

Mines and Minerals Division

**Ontario Geological Survey
Study 35**

Geology of

Carbonatite – Alkalic Rock Complexes in Ontario:

Shenango Township Alkalic Rock Complex

Districts of Sudbury and Algoma

by R.P. Sage

1987



Ontario

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Foreword

The Shenango Township Alkalic Rock Complex was examined as part of a project, begun in 1974, to study alkalic rock – carbonatite complexes in Ontario. The study describes the rock types and mineralogy of the complex and outlines the history of mineral exploration within the complex.

V.G. Milne

Director

Ontario Geological Survey



Contents

Abstract	2
Résumé	2
Introduction	3
Acknowledgments	3
Location and Access	3
Field Methods	5
Previous Geological Work	5
Physiography	5
Laboratory Techniques	5
General Geology	6
Early Precambrian	8
Orthogneiss and Paragneiss	8
Hornblende Gneiss	9
Quartzitic Gneiss	9
Garnetiferous Gneiss	10
Amphibolite	10
Late Precambrian	14
Diorite Porphyry	14
Shenango Township Alkalic Rock Complex	14
Major Lithologic Units	14
Fine-Grained Diorite to Monzonite	14
Coarse-Grained Diorite to Monzonite	17
Monzonite to Quartz Monzonite	19
Quartz Monzonite to Granite	20
Dike Rocks and Minor Units	21
Gabbro	21
Pegmatite Dikes	21
Syenite Dikes	22
Porphyritic Dikes	23
Lamprophyre Dikes	23
Petrology	24
Geochronology	26
Metamorphism	27
Structural Geology	27
Regional Setting	27
Internal Structures	27
Magnetic Response	28
Recommendations for Future Study	29
Economic Geology	31
Property Descriptions	31
Genesco Resources Limited [1969]	31
Kennco Explorations (Canada) Limited [1970]	31
International Minerals and Chemical Corporation (Canada) Limited [1974]	31
Recommendations to the Prospector	31

Appendix A – Petrographic Descriptions and Chemical Compositions	33
References	111
Index	113

TABLES

1. Table of lithologic units for the Shenango Township complex	6
2. Microprobe analyses of amphibole in basaltic xenoliths	12
3. Microprobe analyses of pyroxene in basaltic xenoliths	12
4. Microprobe analyses of plagioclase in basaltic xenoliths	13
5. Microprobe analyses of biotite in hornfels	13
6. Microprobe analyses of pyroxene and plagioclase in coarse-grained diorite to monzonite	18
7. Average electron-microprobe composition of plagioclase in diorite	18
8. K/Ar isotopic age determinations on biotite	27
A-1 Petrographic descriptions of samples	33
A-2 Major element analyses of whole-rock samples	65
A-3 Trace element analyses of whole-rock samples	73
A-4 Normative minerals (CIPW) for whole-rock samples	89
A-5 Average chemical compositions of lithologic units	105

FIGURES

1. Key map showing location of the Shenango Township complex	4
2. Aeromagnetic map of the Shenango Township complex	7
3. Geology of the Shenango Township complex	Chart A
4. AFM plots of samples from the Shenango Township complex	25
5. Rb/Sr isochron plot of samples from the Shenango Township complex ..	26
6. Magnetic data compiled from ground surveys	29

PHOTOS

1. Banded gneiss	8
2. Fine-grained syenodiorite	15
3. Fine-grained brecciated syenodiorite	16
4. Coarse-grained diorite cut by quartz monzonite dikes	16
5. Sharp contact of quartz monzonite to granite with underlying diorite ..	21
6. Coarse-grained diorite cut by pegmatitic monzonite dike	22

CHART (back pocket)

Chart A (coloured) — Figure 3.

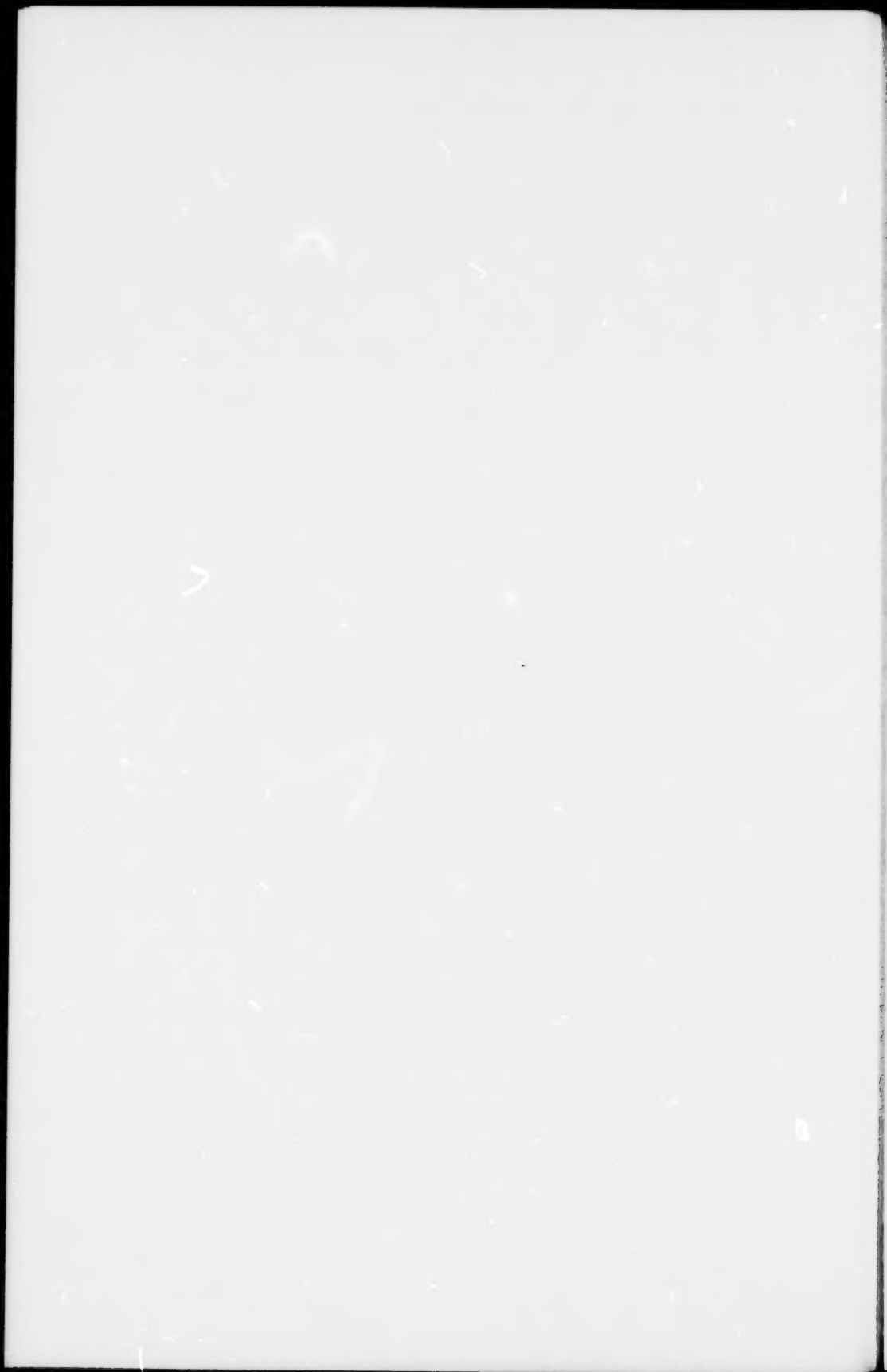
CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	Multiplied by	Gives	Imperial Unit	Multiplied by	Gives
LENGTH					
1 mm	0.039 37	inches	1 inch	25.4	mm
1 cm	0.393 70	inches	1 inch	2.54	cm
1 m	3.280 84	feet	1 foot	0.304 8	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	1.609 344	km
AREA					
1 cm ²	0.155 0	square inches	1 square inch	6.451 6	cm ²
1 m ²	10.763 9	square feet	1 square foot	0.092 903 04	m ²
1 km ²	0.386 10	square miles	1 square mile	2.589 988	km ²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
VOLUME					
1 cm ³	0.061 02	cubic inches	1 cubic inch	16.387 064	cm ³
1 m ³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m ³
1 m ³	1.308 0	cubic yards	1 cubic yard	0.764 555	m ³
CAPACITY					
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	4.546 090	L
MASS					
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	31.103 476 8	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	0.453 592 37	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	907.184 74	kg
1 t	1.102 311	tons (short)	1 ton (short)	0.907 184 74	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	1016.046 908 8	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	1.016 046 908 8	t
CONCENTRATION					
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.



**Geology of
Carbonatite – Alkalic Rock Complexes in Ontario:
Shenango Township Alkalic Rock Complex
Districts of Sudbury and Algoma**

R.P. Sage¹

1. Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Manuscript approved for publication by John Wood, Chief Geologist, Ontario Geological Survey, April 25, 1983.

This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Shenango Township Alkalic Rock Complex is a silica-saturated to silica-oversaturated alkalic rock complex emplaced into the Kapuskasing Subprovince of the Superior Province of the Canadian Shield. The complex is situated marginal to the Shawmere Anorthosite Complex and is thought to have been emplaced into folded orthogneisses. The complex has a rubidium-strontium isochron age of 1047 ± 15 Ma.

The intrusion consists of diorite, syenodiorite, monzonite, and quartz monzonite. An arcuate band of amphibolite in the centre of the complex contains sufficient magnetite to cause a prominent circular aeromagnetic anomaly. The amphibolite band is not petrogenetically related to the Shenango Township Alkalic Rock Complex.

Mineral exploration has failed to disclose economic concentrations of any mineral within the complex. Mineralization commonly associated with silica-undersaturated alkalic rocks is not likely to occur within the Shenango Township Alkalic Rock Complex.

Résumé

Le complexe rocheux alcalin du canton de Shenango est un complexe saturé à hypersaturé en silice. Il se trouve dans la sous-province de Kapuskasing de la province supérieure du bouclier canadien. Ce complexe est situé en bordure du complexe d'anorthosite de Shawmere et l'on pense qu'il a été mis en place dans des orthogneisses plissés. Il est isochrone, on a pu le dater à l'aide de rubidium-strontium à 1047 ± 15 Ma.

L'intrusion consiste en diorite, syénodiorite, monzonite et monzonite quartzifère. La zone arquée d'amphibolite située au centre du complexe contient assez de magnétite pour former une importante anomalie aréomagnétique circulaire. La zone amphibolique n'est pas pétrogénétiquement reliée au complexe rocheux alcalin du canton de Shenango.

La prospection minière n'a pas permis de découvrir de concentrations rentables de minéraux dans le complexe. La minéralisation habituellement associée aux roches alcalines sous-saturées en silice est peu probable dans le complexe rocheux alcalin du canton de Shenango.

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Introduction

The Shenango Township Alkalic Rock Complex is one of several Late Precambrian alkalic intrusions occurring within the Kapuskasing Subprovince of the Superior Province of the Canadian Shield. The rock suite ranges from gabbro to quartz monzonite in composition and represents a more silica-saturated series than other alkalic complexes of similar age within the subprovince. This intrusion is not as favourable for the localization of mineralization of economic interest as the more silica-undersaturated alkalic rocks. Even though of more limited economic potential than other alkalic rock complexes within the Kapuskasing Subprovince, it must be included in any regional study of alkalic rocks.

The complex is probably a concordant intrusive body emplaced into folded gneissic rocks marginal to the Shawmere Anorthosite Complex.

Acknowledgments

The author was assisted in mapping by W. Wright, senior geological assistant, and C. Higgins and P. Chamois, junior field assistants. Mr. Wright mapped the portions of the complex west of Shenango Lake and north of Shenango Lake, the central portion of the complex, and completed several traverses south of Shiners Lake. The author mapped a portion of the area west of Shenango Lake, the area near "Fort" Lake (local name), the Canadian National Railway line, the shoreline of Shiners Lake, and completed several short traverses south of Shiners Lake. The author compiled previously gathered data (Thurston *et al.* 1977) which he had collected during Operation Chapleau.

Aircraft to move camps were supplied by the Ontario Ministry of Natural Resources, Timmins. Mr. R. Elliot, Regional Fire Control, coordinated the logistics for the project.

Mr. H.W. Fleming, Kennco Explorations (Canada) Limited, supplied private data to the project. The International Minerals and Chemical Corporation (Canada) Limited supplied an unpublished report on the apatite potential of the intrusion.

Dr. D. Watkinson, Carleton University, has supplied unpublished manuscripts and data to the project.

Location and Access

The Shenango Township Alkalic Rock Complex lies across the Shenango-Sherlock Townships boundary at approximately 48°24'N Latitude and 82°48'W Longitude (Figure 1). The complex is teardrop-shaped, elongated northeast-southwest, and has an estimated surface area of 66 km². The teardrop shape narrows to the northeast and its general outline is displayed by aeromagnetic contours on ODM-GSC Aeromagnetic Map 2248G (Figure 2).

Access to the complex is by railway or float-equipped aircraft to Shiners Lake or Shenango Lake. Shenango Lake lies along the east flank of the complex and Shiners Lake lies at the north end of the intrusion. The main east-west line of Canadian National Railway crosses the complex at Shiners Lake. The interior of the complex is easily accessible only by helicopter.

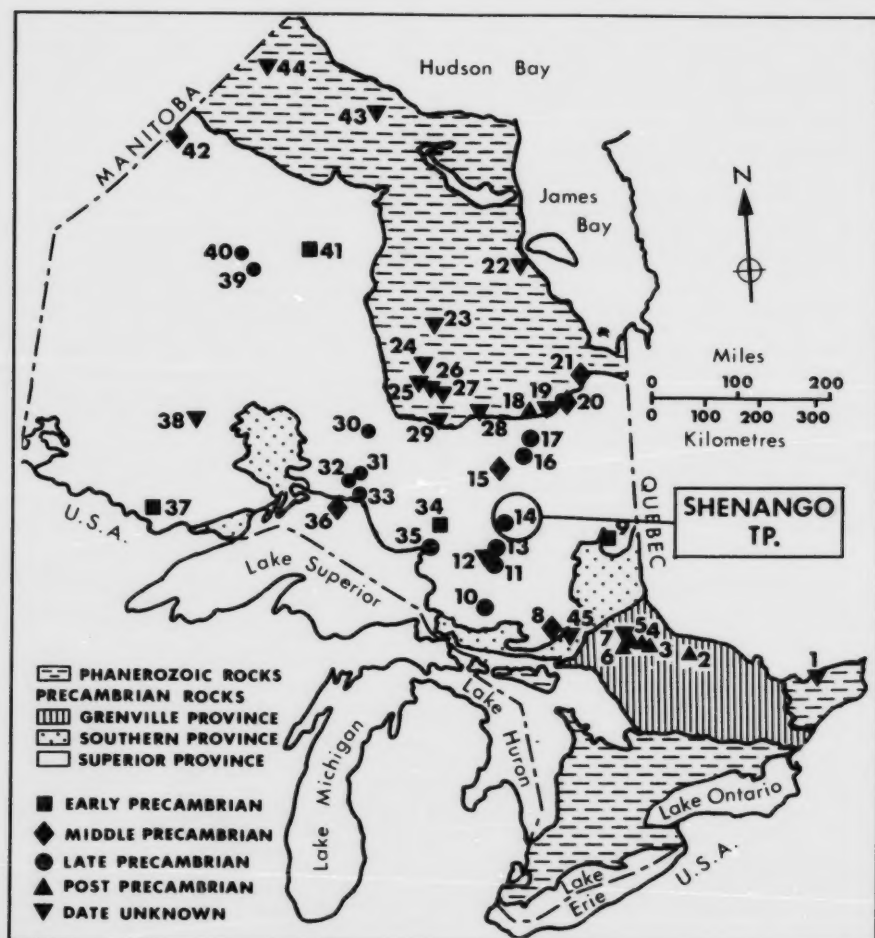


Figure 1. Key map showing location of carbonatite - alkalic rock complexes in Ontario.

- | | | |
|--------------------|------------------------|---------------------------------|
| 1. Eastview | 17. Clay-Howells | 32. Prairie L. |
| 2. Brent | 18. Hecla-Kilmer | 33. Port Coldwell |
| 3. Callander B. | 19. Valentine Tp. | 34. Herman L. |
| 4. Manitou Is. | 20. Goldray | 35. Firesand R. |
| 5. Burritt Is. | 21. Argor | 36. Slate Is. |
| 6. Iron Is. | 22. Lawashi R. | 37. Poohbah L. |
| 7. Lavergne | 23. Poplar R. | 38. Sturgeon Narrows & Squaw L. |
| 8. Spanish R. | 24. Albany Forks | 39. Schryburt L. |
| 9. Otto Stock | 25. L. Drowning R. | 40. Big Beaver House |
| 10. Seabrook L. | 26. Kingfisher R. West | 41. Wapikopa L. |
| 11. Lackner L. | 27. Kingfisher R. East | 42. "Carb" L. |
| 12. Borden L. | 28. Martison L. | 43. Gooseberry Br. |
| 13. Nemegosenda L. | 29. Nagagami R. | 44. Niskibi L. |
| 14. Shenango Tp. | 30. Chipman L. (dikes) | 45. Nemag L. & Lusk L. |
| 15. Cargill Tp. | 31. Killata L. | |
| 16. Teetzel Tp. | | |

Field Methods

Mapping of the complex was by pace and compass methods. Outcrop data were recorded on acetate overlays of 1:15,840 photographs supplied by the Airphoto Library, Ontario Ministry of Natural Resources. The data recorded on acetates were transferred to a cronoflex base map of the same scale supplied by the Cartographic Section of the Ontario Ministry of Natural Resources. Field data were supplemented by private files of the exploration industry and records obtained from the Assessment Files Research Office, Ontario Geological Survey, Toronto. Approximately 15 man-days were spent in mapping the complex.

Previous Geological Work

The first recognition of possible alkalic rocks in the area was by Satterly (1968). The first published geological work on the complex was by Thurston *et al.* (1977), who completed a geological reconnaissance program in the area. Watkinson (personal communication) is currently doing a microprobe-petrologic study of some of the phases of the intrusion.

Physiography

Outcrop is absent or scarce along the western and southern margins of the intrusion. The best exposures are along the shore of Shiners Lake, in railway cuts on the Canadian National Railway right-of-way, and in the centre of the intrusion.

The surface of the complex is generally low and rolling with the exception of a large hill in the centre known as "Bollo Hill" (local name) and a second hill in the northeast corner of the body known as "Cone Hill" (local name). Of the two hills, Bollo is the highest, rising approximately 75 m above the undulating surface.

Laboratory Techniques

Samples were taken from the complex for petrographic and chemical studies. Samples taken for analysis were thin sectioned and half of the slide stained to facilitate the identification of potassium feldspar. Examination of the thin sections was brief and only major textural features were noted.

General Geology

The author visited the complex briefly in 1970 as part of Operation Chapleau (Thurston *et al.* 1977). Work during this past field season modifies some details of the earlier interpretation.

The complex consists of diorite to syenodiorite, monzonite and granitic rocks (Figure 3, Chart A, back pocket). Table 1 lists the lithologic units in the complex. Trace element analyses (Thurston *et al.* 1977) indicated unusually high concentrations of barium and strontium, typical of alkalic complexes.

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE SHENANGO TOWNSHIP ALKALIC ROCK COMPLEX.

CENOZOIC

Recent and Pleistocene

Swamp and stream deposits; glacial drift, boulders, gravel, sand and till.

Unconformity

LATE PRECAMBRIAN (PROTEROZOIC)

Shenango Township Alkalic Rock Complex

Dike Rocks

Syenite, lamprophyre, plagioclase-biotite porphyritic syenite (units 2e,h,k).

Intrusive Contact

Quartz Monzonite to Granite

Quartz monzonite, granite, fine to medium grained, locally aplitic to pegmatitic (unit 2a).

Intrusive Contact

Monzonite to Quartz Monzonite

Monzonite, quartz monzonite, fine to medium grained, locally pegmatitic (unit 2b).

Intrusive Contact

Diorite to Monzonite

Diorite, syenodiorite, monzonite, fine to coarse grained, rare gabbro (units 2c,d,f).

Intrusive Contact

EARLY PRECAMBRIAN (ARCHEAN)

Orthogneiss and paragneiss

Hornblende-plagioclase gneiss, quartz-hornblende-plagioclase gneiss, amphibolite, quartz-biotite-hornblende-plagioclase gneiss, hornblende-garnet-plagioclase gneiss, garnet-quartz-hornblende-plagioclase gneiss, granitic pegmatite dikes (units 1a-g).

The diorite to syenodioritic rocks can be readily divided into two map-units. On Shiners Lake and extending southwestward from the lake is a large body of pink-grey to buff weathering, coarse-grained, massive, alkalic diorite. The rock is equigranular and locally has a weak trachytoidal texture. In the vicinity of Shenango Lake, west of Shenango Lake, and in rock cuts of the Canadian National Railway line immediately west of Shiners Lake, is a fine-grained, massive,

equigranular syenodiorite. Rocks of this fine-grained unit form arcuate masses that intrude, in lit-par-lit fashion, the gneissic rocks of the Kapuskasing Subprovince. This unit was not observed in contact with the coarse-grained, alkalic diorite found at Shiners Lake. It is common in the central portions of the complex centered on "Barry" Lake (local name). Fractures in the fine-grained syenodiorite are commonly filled with coarse-grained, pegmatitic monzonitic to granitic rocks.

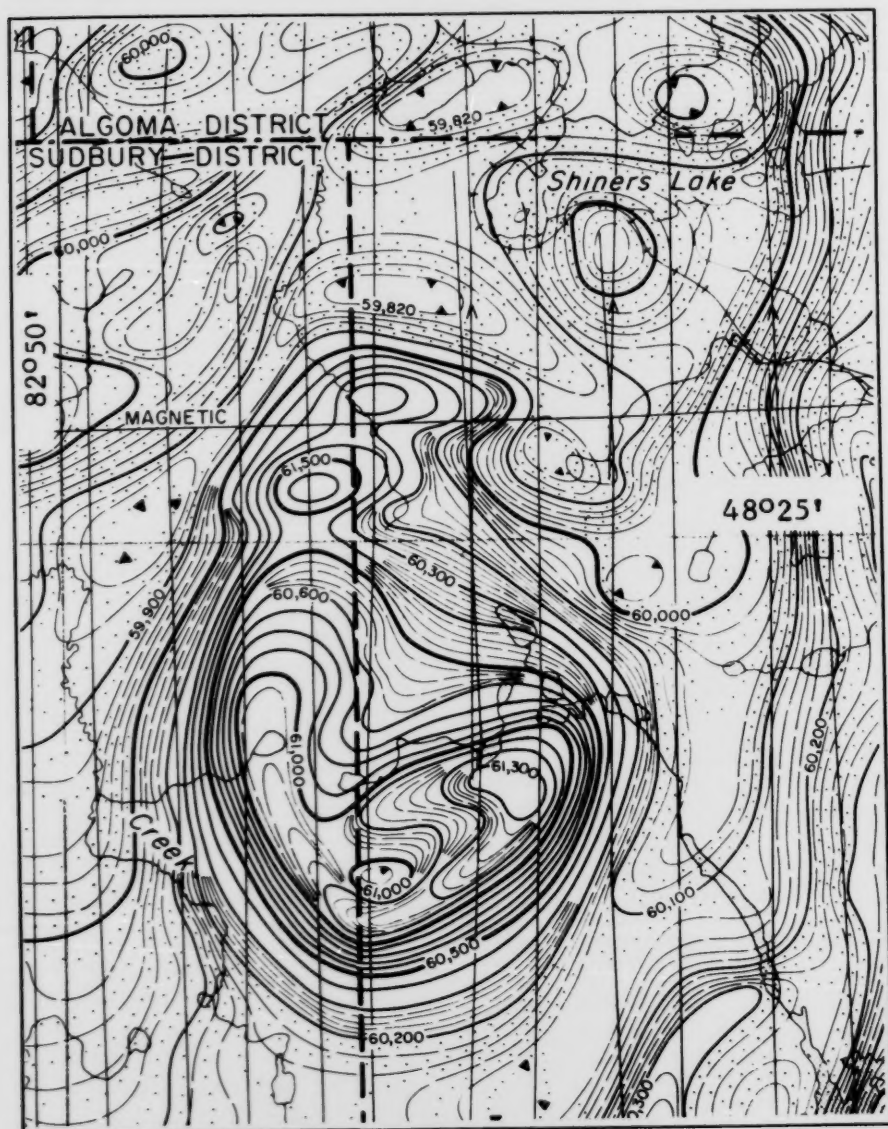


Figure 2. Aeromagnetic map of the Shenango Township Alkalic Rock Complex (from Aeromagnetic Map 2248G, ODM-GSC 1963).

Monzonitic rocks intrude the diorites and display sharp contacts. These rocks weather red to red-brown in colour, are massive, highly variable in grain size between occurrences, equigranular within a given occurrence, and contain a dark green to black, somewhat acicular, amphibole. This rock type generally occurs as small masses and dikes. A pegmatitic monzonite phase is present in some exposures along the Canadian National Railway right-of-way.

The granitic phases weather bright red to red-brown, are generally very fine grained, leucocratic, and aplitic. This unit, though it sharply cross-cuts the dioritic and monzonitic phases, rarely forms dikes or masses of mappable size.

The curvilinear amphibolite band within the complex has a minor quantity of magnetite within it which causes the prominent horseshoe-shaped anomaly on the aeromagnetic map (Figure 2). The amphibolite displays well developed metamorphic textures in thin section and is likely of Early Precambrian age and unrelated to the fresh looking alkalic rocks (Thurston *et al.* 1977). Elliptical clots of quartz and epidote within the amphibolite band suggest the possibility that the amphibolite was derived from a series of amygdaloidal flows.



Photo 1. Banded gneiss. The banding is due to alternating layers of amphibolite and trondhjemite. Location P-1, southwest corner of Shiners Lake.

EARLY PRECAMBRIAN (ARCHEAN)

ORTHOgneiss AND PARAGneiss

Rocks enclosing the Shenango Township Alkalic Rock Complex lie within the Kapuskasing Subprovince of the Superior Province. Reconnaissance mapping (Thurston *et al.* 1977) of the area in 1970 indicated that the rocks marginal to the Shenango Township Alkalic Rock Complex are gneissic rocks metamorphosed to the granulite facies rank of regional metamorphism (Thurston *et al.* 1977). Outcrops of the enveloping wall rocks occur along the shorelines of small unnamed lakes west of Shenango Lake; at several locations on Shenango Lake; and in railway rock-cuts. Gneissic rocks are best exposed on islands and along

the shoreline at the west end of Shiners Lake (Photo 1) and along the railway. Less accessible exposures are found on the unnamed lakes west of Shenango Lake. The author believes that the gneissic rocks are almost exclusively orthogneiss but the presence of paragneiss cannot be discounted. Some of the rocks may be related to and represent phases of the Shawmere Anorthosite Complex, but much additional field work would be required to substantiate this possibility.

Hornblende Gneiss

Hornblende-plagioclase gneiss (unit 1a) is most common west of Shenango Lake where it forms several large outcrops. It is also present in minor amounts in railway rock-cuts on the northeast flank of the intrusive complex. The rocks are gneissic, medium grained, and are mottled pink and black on both weathered and fresh surfaces. The gneissic banding is due to variations in the ratio of hornblende to feldspar.

In thin section the rock is medium grained, equigranular, massive, aliotriomorphic, with curved grain boundaries. The rock is estimated to consist of 40 to 60 percent plagioclase (An 32-41), 10 to 40 percent amphibole (hornblende), 0 to 30 percent biotite, and 0 to 30 percent augite pyroxene. Minor to trace amounts of olivine, sericite, magnetite, and apatite are present. The plagioclase forms anhedral grains interlocked with the amphibole, biotite, or pyroxene. The amphibole forms pleochroic brown, yellow-brown to green-brown anhedral grains. The biotite is closely associated with the amphibole and some amphibole poikilitically encloses biotite inclusions in those hornblende-plagioclase samples containing abundant biotite. The pyroxene shows a patchy alteration to hornblende, which gives the grains a mottled appearance. Amphibole may also mantle or rim the pyroxene grains.

The hornblende-plagioclase gneiss is most likely an orthogneiss.

Quartzitic Gneiss

Quartz-hornblende-plagioclase to hornblende-quartz-plagioclase gneiss, and quartz-biotite-hornblende-plagioclase gneiss (units 1b, 1d) occur west of Shenango Lake, on the west side of Shiners Lake, and in numerous outcrops along the Canadian National Railway. The two map-units are gradational into each other, and are distinguished from each other on the basis of biotite content. Quartz-biotite-hornblende-plagioclase gneiss contains more than 10 percent biotite. In thin section these units are medium grained, equigranular, massive, aliotriomorphic, with curved grain boundaries. The modal composition of these units is estimated as 10 to 25 percent quartz, 15 to 60 percent amphibole (hornblende), 30 to 60 percent plagioclase (An 31-54), and 0 to 20 percent biotite. Biotite is common in most thin sections. Trace to minor sericite, apatite, zircon, magnetite, chlorite, garnet and carbonate were noted in one or more thin sections. The quartz is anhedral and forms isolated grains or aggregates of grains interlocking with each other and feldspar. The amphibole is pleochroic in brown and may poikilitically contain inclusions of biotite. In one section the amphibole is rimmed with fine-grained biotite which appears to have broken down to a very fine-grained mixture of biotite and plagioclase. Elongated discontinuous streaks composed of amphibole and biotite define the gneissosity.

Biotite occurs in brown anhedral grains in association with amphibole and in some cases as an alteration of the amphibole.

Plagioclase is anhedral in outline and forms an interlocking mosaic of grains. Some plagioclase is weakly saussuritized.

Garnetiferous Gneiss

Garnet is locally present in the gneissic rocks (units 1e,f) and, in some hand specimens of garnet-quartz-hornblende-plagioclase gneiss, can be seen as tiny grains, 1 mm or less in diameter. Garnet was observed in one thin section of a sample collected in a railway cut west of Shiners Lake. In this section large grains of garnet have very well developed kelyphytic rims consisting of fine-grained symplectic intergrowths of quartz (?) and plagioclase (?). The intergrowths are oriented normal to the grain margins of the garnet which comprises 5 percent of the rock.

In one sample collected from a railway cut southeast of Shiners Lake, garnet constitutes an estimated 10 percent of the rock. The garnet in this sample forms euhedral to subhedral grains and lacks kelyphytic rims. This garnet rock contains an estimated 15 percent orthopyroxene which has in part altered to biotite and actinolite. Some clinopyroxene is also present and has undergone similar alteration. The rock also contains 25 percent pleochroic brown to green-brown anhedral hornblende, 5 percent brown anhedral biotite, 40 percent anhedral plagioclase (An 30-35), and 5 percent quartz. The feldspars and quartz form an interlocking mosaic and the mafics are segregated into bands giving rise to a gneissosity.

One outcrop of hornblende-garnet-plagioclase gneiss in a railway cut east of the complex has been distinguished from the other garnetiferous gneisses. The garnet is deep red, forms rounded porphyroblasts up to 3 cm in diameter and constitutes an estimated 15 to 20 percent of the outcrop. The rock is mottled red (garnet), green-black (hornblende) and grey (plagioclase) and is medium to coarse grained. The author believes that this rock is an appendage or a satellite intrusion of the Shawmere Anorthosite Complex located immediately southeast of the Shenango Township Alkalic Rock Complex. The author has seen analogous rocks in the Shawmere complex and these rocks have been described by Thurston *et al.* (1977).

In thin section the rock is medium grained, massive, equigranular, aliotriomorphic, granoblastic, with straight to curved grain boundaries. The mode is estimated to be 35 percent plagioclase (An 50-58), 15 percent garnet, 50 percent hornblende, and a trace of magnetite. The garnet is anhedral and poikilitically contains inclusions of amphibole, plagioclase, and magnetite. The amphibole is anhedral brown hornblende which is interlocked with plagioclase. The plagioclase forms an interlocking mosaic of anhedral grains.

The gneissic rocks are locally cut by pegmatite dikes of variable strike, attitude, and width (unit 1g). It is possible that some of these dikes are related to the Shenango Township Alkalic Rock Complex, but the author considers it more likely that most of them were emplaced during a late Archean intrusive event. The dikes are undeformed, appear unmetamorphosed, and contain 15 to 20 percent quartz and 80 to 85 percent pink-grey microcline. The microcline crystals are up to 7 cm in width on a cleavage face.

Amphibolite

Within the Shenango Township Alkalic Rock Complex a horseshoe-shaped unit of banded amphibolite (unit 1c) is responsible for a prominent aeromagnetic pattern (ODM-GSC 1963). This aeromagnetic anomaly prompted Satterly (1968) to interpret the area as the site of a possible alkalic rock - carbonatite intrusion.

In outcrop the amphibolites are fine-grained and weather black and green-black. Banding is generally 10 cm or less in width. The banding is due to two

variables: (1) varying ratios of mafic minerals to feldspar, and (2) slight variations in grain size. Distinct zones of possible amygdules are locally common within what otherwise appears as homogeneous amphibolite. These possible amygdules are composed of quartz, hornblende, chlorite and epidote. They are elongated in the plane of gneissosity and in places exceed 1.5 cm in maximum dimension. The quartz-epidote clots weather up to 0.5 cm above the surrounding amphibolite giving the rock a rough studded surface. The amphibolite has been extensively intruded by rocks of the Shenango Township Alkalic Rock Complex. Amphibolite also occurs as short curvilinear bands and as isolated xenolithic blocks within the complex. On the basis of ground magnetic data, several thin bands of amphibolite have been interpreted to be present within the complex. Minor disseminated sulphide mineralization sometimes occurs in the amphibolite. The amphibolite or mafic metavolcanic is a hornfels which may be a remnant of the Belford-Strachan metavolcanic-metasedimentary belt (Bennett 1969) which may have extended across this area at the time of emplacement of the Shenango complex and subsequently has been eroded away.

Locally diffuse contacts between the dioritic to quartz monzonitic rocks of the Shenango complex and mafic volcanic hornfels suggest that the alkaline rocks have assimilated the mafic volcanic hornfels, whereas in other cases the contacts are sharp and crosscutting, indicating little hybridization of the rocks. Local accumulations of volatiles in the alkaline magma may have promoted local assimilation of the amphibolites causing hybridization of the alkaline rocks.

In thin section the rocks are fine grained, massive, equigranular, granoblastic, with curved grain boundaries. Modally the rocks are estimated to consist of 45 to 55 percent plagioclase (An 40-55), 40 to 55 percent hornblende, 0 to 15 percent quartz, 0 to 5 percent biotite, and 2 to 5 percent magnetite. The hornblende is pleochroic in brown, anhedral in outline, and interlocks with anhedral plagioclase. D. Watkinson (Carleton University, personal communication, 1977) reported the presence of pyroxene in some mafic volcanic hornfels samples examined by him.

In thin section the texture is generally typical of amphibolitic rocks. Thin sections prepared from samples collected by the author in 1970 display well developed poikiloblastic textures with anhedral plagioclase enclosed in hornblende and anhedral hornblende in plagioclase. The quartz, if present, occurs as wispy, elongated, granular, textured clots, some of which may represent former amygdule fillings. The hornfels is likely of mafic volcanic origin and represents volcanic blocks and roof pendants metamorphosed to hornblende hornfels rank.

Watkinson (personal communication, 1977) performed microprobe analyses on the mafic mineral phases in samples taken predominantly from the diamond drill core of Kennco Explorations (Canada) Limited. Tables 2, 3, 4, and 5 are compilations of some of these analyses.

TABLE 2. AVERAGE ELECTRON MICROPROBE ANALYSES OF AMPHIBOLES FROM BASALT XENOLITHS IN THE SHENANGO TOWNSHIP COMPLEX (COMPILED FROM UNPUBLISHED DATA OF WATKINSON 1977).

Sample	1	2	3	4	5	6	7	8
FeO	12.72	7.18	7.54	12.97	15.76	14.65	13.41	14.07
MgO	14.78	20.33	19.20	13.80	12.79	13.42	14.61	14.48
SiO ₂	48.28	50.14	51.37	46.38+	45.59	46.73	46.50	47.30
Al ₂ O ₃	6.27	6.04	5.71	7.95	8.63	8.29	7.89	6.77
CaO	12.33	11.80	12.47	11.58	11.93	12.40	12.03	12.09
Na ₂ O	1.41	0.84	0.62	1.10	1.12	1.37	1.41	1.09
K ₂ O	0.52	N.D.	0.13	0.71	0.82	0.71	0.74	0.56
TiO ₂	0.53	N.D.	0.08	0.48	0.58	0.74	0.56	0.67
MnO	N.D.	N.D.	N.D.	N.D.	0.33	N.D.	0.34	N.D.
Total	96.85	96.33	97.12	94.97	97.55	98.31	97.49	97.03

NOTES: All analyses by P. Morton except Sample 2, which was analyzed by R. Colly;
+ Low in Si - poor analysis; N.D. Not determined.

SAMPLES.

1. Average of 6 analyses of magnesio-hornblende and edenite in basaltic xenolith from DDH 1, footage 71', (C-1-2).
2. Average of 6 analyses of magnesio-hornblende in basaltic xenolith from DDH 1, footage 240', (C-1-10).
3. Average of 6 analyses of actinolitic-hornblende and actinolite in basaltic xenolith from DDH 1, footage 360', (C-1-14).
4. Average of 4 analyses of magnesio-hornblende in basaltic xenolith from DDH 1, footage 425', (C-1-18).
5. Average of 9 analyses of magnesio- to edenitic-hornblende in "hybrid" basaltic xenolith from DDH 2, footage 355', (C-2-22).
6. Average of 3 analyses of magnesio- to edenitic-hornblende in "hybrid" basaltic xenolith from DDH 2, footage 490', (C-2-30).
7. Average of 2 analyses of magnesio-hornblende after diopsidic augite in syenite from DDH 2, footage 355', (C-2-22).
8. Average of 4 analyses of magnesio-hornblende after diopsidic augite in syenite from DDH 2, footage 490', (C-2-30).

TABLE 3. ELECTRON MICROPROBE ANALYSES OF PYROXENE GRAINS FROM BASALT XENOLITHS IN THE SHENANGO TOWNSHIP COMPLEX (COMPILED FROM UNPUBLISHED DATA OF WATKINSON 1977).

Sample	3a	3b	3c
FeO	7.31	6.85	7.00
MgO	14.57	15.42	14.50
SiO ₂	52.87	52.23	51.52
Al ₂ O ₃	0.81	1.31	1.02
CaO	24.09	24.34	24.14
Na ₂ O	0.26	0.33	0.29
K ₂ O	-	-	0.01
TiO ₂	0.09	0.04	0.07
Total	100.0	100.52	98.54

NOTES: 3a,b,c: Pyroxene grains in basaltic xenolith of DDH 1, footage 71', (C-1-2).
Analyst - Penny Morton.

TABLE 4. AVERAGE ELECTRON MICROPROBE ANALYSES OF PLAGIOCLASE FROM BASALT XENOLITHS IN THE SHENANGO TOWNSHIP COMPLEX (COMPILED FROM UNPUBLISHED DATA OF WATKINSON 1977).

Sample	2	3	4	5	6	7
SiO ₂	62.42	56.69	55.86	56.17	54.78	59.10
Al ₂ O ₃	22.33	27.55	27.67	27.70	28.21	25.44
CaO	6.50	9.23	10.09	9.87	10.75	7.11
Na ₂ O	8.14	6.23	5.54	5.97	5.84	7.31
K ₂ O	0.26	0.10	0.03	0.13	0.14	0.23
Total	99.65	99.70	99.19	99.84	99.72	99.19

SAMPLES

2. Average of 12 grains from mafic xenolith sample 07006.
3. Average of 6 grains from basaltic xenolith DDH-1, (C-1-2).
4. Average of 6 grains from basaltic xenolith DDH-1, (C-1-10).
5. Average of 4 grains from basaltic xenolith DDH-1, C-1-14.
6. Average of 2 grains from mafic zone in hybrid xenolith, DDH-2, C-2-30.
7. Average of 4 grains from syenitic zone in xenolith, DDH-2, C-2-30.

TABLE 5. ELECTRON MICROPROBE ANALYSES OF TiO₂, FeO AND MgO CONTENTS OF BIOTITE FROM HORNFELSIC ROCKS IN THE SHENANGO TOWNSHIP COMPLEX (COMPILED FROM UNPUBLISHED DATA OF WATKINSON 1977).

Sample Number											
1	2	3	4	5	6	7	8	9	10	11	12
% Biotite in Sample (Visual estimate)											
25	tr	tr	12	12	tr	25	25	10	10	10	25
Analyses											
TiO ₂	1.52	0.77	0.82	1.57	1.72	2.49	1.35	1.82	2.43	2.37	1.34
FeO	18.52	9.40	9.21	16.20	15.93	16.61	12.51	13.18	13.72	14.01	12.99
MgO	14.06	20.75	21.09	14.98	15.14	13.11	17.41	16.66	16.20	15.96	17.03
F/M Ratio											
0.739	0.254	0.245	0.607	0.590	0.617	0.403	0.444	0.475	0.493	0.482	0.428
F/F+M Ratio											
0.425	0.203	0.197	0.378	0.371	0.318	0.287	0.307	0.322	0.330	0.325	0.300

SAMPLES.

1. Biotite in matrix of hornfels of hybrid rock in C-2-22 (DDH 2).
2. & 3. Biotite after actinolitic hornblende in C-1-14 (DDH 1) (retrograde?).
4. & 5. Biotite in matrix of hornfels of hybrid rock in C-2-30 (DDH 2).
6. Biotite in syenitic section of hybrid rock in C-2-30 (DDH 2).
7. to 12. All from C-1-18 (DDH 1): 7,8,12 in hornfelsic, & 9,10,11 in syenitic part of sample.

LATE PRECAMBRIAN (PROTEROZOIC)

Diorite Porphyry

At several locations a distinctive diorite porphyry was observed in outcrop. This phase is of very limited extent, erratic distribution, and generally displays close spatial distribution with the amphibolite. It occurs between the amphibolite and various phases of the alkalic rock complex and is likely of hybrid origin. This rock type was found west of "Barry" Lake (local name) and south of "Fork" Lake (local name) and is of such limited distribution that the author did not code it on the accompanying map.

In outcrop the rock is massive and displays a well developed trachytoidal texture. The plagioclase phenocrysts are platy, up to 3 cm in length and may constitute an estimated 20 percent of the rock.

In thin section the rock is fine to coarse grained, inequigranular-porphyritic-seriate, allotriomorphic, with curved grain boundaries. In one section the mode was estimated as 15 to 20 percent pyroxene (augite), 5 to 15 percent biotite, 2 to 4 percent magnetite, 45 to 50 percent plagioclase (An 38-48), and 15 to 25 percent amphibole (hornblende). Trace amounts of olivine and apatite are present.

The amphibole forms anhedral, pleochroic brown grains and the pyroxene forms anhedral, colourless grains. The anhedral plagioclase of the groundmass contains inclusions of amphibole and pyroxene. The subhedral plagioclase phenocrysts are locally fractured and saussuritized and have an occasional inclusion of biotite, amphibole and pyroxene. The biotite forms anhedral grains in close association with amphibole.

SHENANGO TOWNSHIP ALKALIC ROCK COMPLEX

MAJOR LITHOLOGIC UNITS

Fine-Grained Diorite to Monzonite

Fine-grained diorite to monzonite (unit 2d) outcrops east of Shenango Lake, on bays off the northwest arm of Shenango Lake, on the shore line of "Long" Lake, and in railway rock cuts on the west side of Shiners Lake. The rock is fine grained, massive, equigranular and commonly is cut by ramifying dikes or fracture fillings of leucocratic, medium-grained quartz monzonite. These dikes are sometimes so pervasive as to give the outcrop the appearance of an intrusive breccia (Photos 2 and 3). The quartz monzonite filling the fractures is sometimes sufficiently coarse-grained to be classed as pegmatite. These dikes or fracture fillings have sharp contacts with the diorite to monzonite host. Since dikes of similar composition were not observed to cut the wall rock gneisses, the fracture fillings are an integral part of the Late Precambrian alkalic magmatism related to the diorite to monzonite unit.

On the basis of one or two thin sections the author has previously classified this unit as syenodiorite (Thurston *et al.* 1977). Twenty-six thin sections of this rock type were examined during the present study. The bulk composition is that of syenodiorite but sufficient variation exists to give the unit a broader classification of diorite to monzonite. The composition of one of the thin sections is gabbro and another is syenite.

Photo 2. *Fine-grained syenodiorite. Horizontal fractures are filled with monzonite to quartz monzonite. Local area of brecciated syenodiorite can be seen at top of photograph. Cementing material of breccia is the same as that filling the horizontal fractures. Location P-6.*



In thin section the rock is fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Uncommonly the rock is hypidiomorphic. An estimate of the mode is 0 to 30 percent pyroxene (augite), 0 to 40 percent amphibole (hornblende), 0 to 25 percent biotite, 0 to 60 percent plagioclase (An 28-54), and 0 to 60 percent perthite. Trace to minor amounts of zircon, apatite, sphene, quartz, garnet, olivine (altered to iddingsite?), carbonate, myrmekite, chlorite, magnetite, and microcline were noted in one or more thin sections. Apatite is by far the most common accessory mineral. The apatite occurs in amounts approaching an estimated 1 percent; it is euhedral in outline and is poikilitically enclosed in biotite, pyroxene, amphibole and feldspars.

The pyroxene forms anhedral, colourless grains commonly mantled with pleochroic green amphibole and has undergone spotty replacement by amphibole. Rarely biotite has replaced the pyroxene.

The pyroxene poikilitically encloses euhedral apatite crystals. One or two grains exhibit a weak concentric zoning. Moderate to strong zoning of the pyroxene is evident in the section having the composition of gabbro.

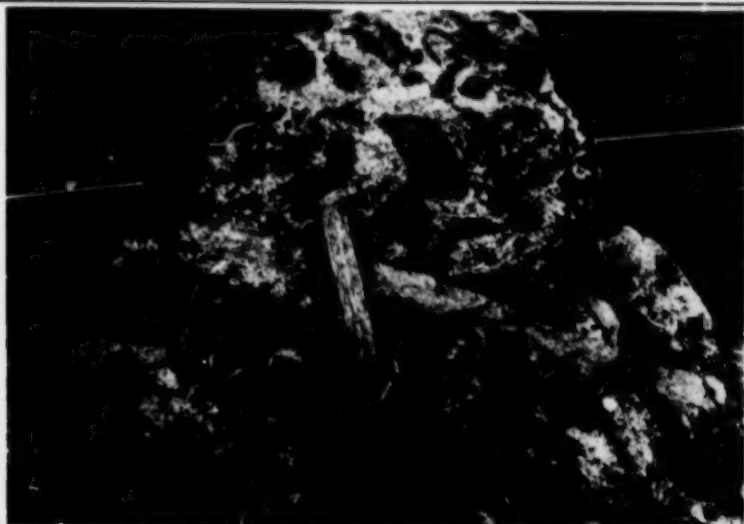


Photo 3. *Fine-grained syenodiorite, brecciated and cemented with monzonite to quartz monzonite. Breccia is cut by monzonite dike (beneath hammer handle). Location P-5.*



Photo 4. *Coarse-grained diorite cut by quartz monzonite dikes. Location P-3.*

The biotite forms brown, anhedral to subhedral grains and commonly is closely associated and interlocked with amphibole. Biotite appears to have replaced amphibole and pyroxene in some sections and may partially enclose some grains of plagioclase and amphibole.

The plagioclase forms an interlocking mosaic of anhedral grains. Though it varies from oligoclase to labradorite in composition, the dominant composition is andesine. The more calcic plagioclases are characteristic of diorite and the more sodic members are characteristic of monzonite. The plagioclase has been noted to

contain small, acicular, euhedral inclusions of apatite. The plagioclase grains may display a weak to spotty saussuritization, rarely display a faint concentric zoning, and in places display the development of myrmekite along the edges of the grains. Several grains are fractured and have bent albite twin lamellae which define a weakly to moderately developed protoclastic texture.

The perthite displays a string texture and is interlocked with, and locally interstitial to, and partially encloses, the plagioclase. Visual evidence of a perthitic texture is sometimes evident only at the highest magnification and the plagioclase content locally is dominant over the potassium feldspar, forming antiperthite. Several thin sections contain grains with weak vestiges of the quadrille twinning of microcline. Several grains of patch perthite with vestiges of albite twinning were noted in one or more thin sections. The patch perthite likely formed by potassium feldspar replacement of plagioclase.

Coarse-Grained Diorite to Monzonite

Medium- to coarse-grained rocks at Shiners Lake and at scattered locations near "Fork" and "Barry" Lakes (local names), have been mapped as diorite (unit 2c) (Photo 4). The dioritic rocks at Shiners Lake weather grey, buff to pink-buff and those near "Barry" and "Fork" Lakes have a slightly deeper pink to red tint. On fresh surface the rock is buff to pink-buff in colour. Rarely a very crude trachytoidal texture and weak banding is vaguely recognizable. On two outcrops, the coarse-grained diorite is represented by two phases. The older phase has a colour index of about 40, and shows sharp contact relations with the more leucocratic (colour index 25 to 30) phase. These two phases have not been separated on the accompanying map. It is unclear which phase intruded which, but the author assumes the more leucocratic phase is later than the more mafic phase.

In thin section the rock has the compositions of diorite, syenodiorite, and monzonite to quartz monzonite. Quartz-bearing varieties are rare, and one section is gabbro in composition.

The rock is medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. A large number of thin sections have a hypidiomorphic rather than allotriomorphic texture. A dominant textural characteristic of this map-unit is moderate to excellent development of protoclastic textures. Fracturing and bending of the plagioclase grains is common, and bent biotite grains are also common in some thin sections.

An estimate of the mode is 0 to 25 percent pyroxene (augite), 0 to 30 percent amphibole (hornblende), trace to 35 percent biotite, 20 to 70 percent plagioclase (An 28-60), and 0 to 45 percent perthite.

Trace to minor amounts of myrmekite, apatite, chlorite, magnetite, zircon, sphene, olivine, sericite, carbonate, and tremolite are present in one or more thin sections. Apatite is common in amounts of approximately 1 percent and is present in several thin sections in amounts estimated as 5 to 10 percent. It occurs as euhedral crystals poikilitically enclosed in biotite. The myrmekite occurs as fine grained quartz (?) and plagioclase (?) intergrowths intergranular to the major feldspar components.

The pyroxene forms anhedral grains commonly mantled with amphibole. The pyroxene has also undergone a patchy alteration to amphibole giving rise to a patchy extinction pattern under crossed nicols. Biotite in some cases has replaced and mantled the pyroxene or occurs as a patchy replacement.

The amphibole is pleochroic in green, yellow green, and green-brown. The amphibole is anhedral in outline and commonly replaces pyroxene. The amphibole is closely associated with biotite.

The biotite forms anhedral, sometimes ragged, brown grains in association with amphibole and pyroxene. The biotite locally has replaced the pyroxene and may possibly have replaced some of the amphibole. The biotite locally forms an interlocking aggregate of grains, and some larger biotite grains display bent (001) cleavage planes. Rarely the (001) cleavage displays kink bands.

TABLE 6. MICROPROBE ANALYSES OF PYROXENE FROM DIORITE (UNIT 2C), SHENANGO TOWNSHIP COMPLEX. (UNPUBLISHED DATA COMPILED FROM WATKINSON 1977).

Sample	1a	1b	1c
FeO	14.45	15.04	14.38
MgO	9.94	10.99	10.39
SiO ₂	51.77	51.37	51.20
Al ₂ O ₃	N.D.	N.D.	N.D.
CaO	22.04	22.58	22.24
Na ₂ O	0.59	0.48	0.49
K ₂ O	N.D.	N.D.	N.D.
TiO ₂	0.37	0.40	0.49
Total	99.15	100.05	99.19

SAMPLES: 1a, b, c — Pyroxene grains in medium-grained diorite at Shiner's Lake (Ag-20-11).

Analyst — Dave Watkinson.

TABLE 7. AVERAGE ELECTRON MICROPROBE ANALYSES OF PLAGIOCLASE FROM DIORITE (UNIT 2C), SHENANGO TOWNSHIP COMPLEX. (UNPUBLISHED DATA COMPILED FROM WATKINSON 1977).

Sample	1
SiO ₂	59.90
Al ₂ O ₃	25.46
CaO	7.75
Na ₂ O	6.76
K ₂ O	N.D.
Total	99.87

SAMPLE: 1. Average of 4 grains of plagioclase in Ag-20-11, diorite.

The plagioclase is anhedral to subhedral, often displays bent albite twin lamellae, and is fractured. The protoclastic texture is very well developed in a number of thin sections and present in almost all. Plagioclase forms an interlocking mosaic of grains, some of which are weakly saussuritized. Zoning within the larger plagioclase grains is present but uncommon. Some zoned crystals display saussuritized cores and relatively fresh rims. Though plagioclase composition varies from oligoclase to labradorite, the dominant composition is andesine. The perthite is of the string type and occurs as anhedral grains interstitial to the plagioclase. The perthite uncommonly has vestiges of albite twinning and in places partially encloses plagioclase grains. Rarely the perthite encloses randomly oriented plagioclase grains. Some grains exhibit the perthitic texture only at the highest magnification and several grains have a weak suggestion of quadrille twinning, which is common to microcline.

The vestiges of albite twinning in several perthite grains imply that some of the perthite may have formed by replacement of plagioclase by potassium feld-

spar. This feature is uncommon and replacement of plagioclase by potassium feldspar is considered to be a very minor feature of this rock unit.

The protoclastic textures within this rock type are ubiquitous, and may be the result of filter pressing of crystal mush during emplacement. The younger, more alkalic-rich and silica-rich phases of this complex could conceivably be the filter pressed, decanted liquid.

Watkinson (Carleton University, personal communication, 1977) has microprobed a diorite sample taken close to sample 649 (see Appendix A). The results of this work are given in Tables 6 and 7.

Monzonite to Quartz Monzonite

Cutting the diorite to syenodiorite and diorite to monzonite map-units are fine- to medium-grained monzonitic rocks (unit 2b). Medium-grained phases of this unit were noted west of "Barry" Lake, east of "Fork" Lake and on the portage between Shenango and "Long" Lake. Most rocks falling into this group are fine-grained and aplitic in appearance. The quartz monzonite to granite map-unit is distinguished from the monzonite to quartz monzonite map-unit on the basis of quartz content (the former contains more than 10 percent quartz). The smaller, finer grained dikes or phases of monzonite to quartz monzonite tend to be more leucocratic than the coarser phases or thicker dikes. This lithologic unit was originally defined by the author (Thurston *et al.* 1977) on the basis of three thin sections and it has now been considerably modified on the basis of a study of 32 sections. Only one possible occurrence of a dike of monzonite, quartz monzonite, or granite cutting the gneissic wall rock was observed.

In outcrop the rock weathers red, pink, or brown-red and on fresh surface similar colours prevail. The contact between the monzonite to quartz monzonite and the older phases are sharp but trends are erratic and in some cases the outcrop has the appearance of intrusive breccia.

In thin section the rock is fine to medium grained, massive, equigranular to inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Uncommonly, some sections are microporphyritic-seriate. Hypidiomorphic textures are not uncommon and several sections display a micro-trachytic texture defined by the preferred orientation of tabular feldspars.

The mode is estimated to be 0 to 3 percent amphibole (hornblende), 0 to 75 percent perthite, 0 to 75 percent plagioclase (An 4-13), and 0 to 20 percent biotite. In addition to the dominant mineral phases noted above, quartz, microcline, and myrmekite were abundant or major constituents in a number of thin sections. Minor to trace amounts of magnetite, zircon, sericite, pyroxene, sphene, and apatite were noted in one or more samples.

Amphibole forms pleochroic green, dark green, brown-green, or green-brown anhedral grains. Biotite is commonly closely associated with the amphibole and rarely has replaced the amphibole. Rarely, the amphibole is subhedral in outline. On the basis of pleochroism, some of the amphibole is an iron- and sodium-rich variety.

Perthite forms anhedral grains. Some perthite grains display well developed string perthite texture and some grains, which are patchy in texture, are antiperthite. The patch-type perthite has diffuse vestiges of albite twinning separated by clear untwinned areas of potassium feldspar. The perthite is in part interstitial and interlocked with the plagioclase.

The plagioclase is anhedral, uncommonly displays protoclastic texture and locally is moderately to weakly saussuritized. Several larger plagioclase grains in

one or two thin sections display a weak concentric zoning. Patchy potassium feldspar replacement of the plagioclase was observed in a number of thin sections. The plagioclase is predominantly sodic oligoclase.

Biotite forms brown, anhedral grains in close association with the amphibole which it uncommonly has replaced.

Quartz is present as anhedral, interlocking, intergranular or interstitial grains.

Microcline forms anhedral grains with weak to well developed quadrille twinning. The microcline feldspar is interstitial to, and interlocked with, plagioclase and perthite.

Myrmekite consisting of fine-grained, vermicular intergrowths of quartz (?) and feldspar (?) occurs in a number of thin sections. The myrmekite occurs as irregular patches along grain boundaries and intergranular to the feldspars.

Quartz Monzonite to Granite

Rocks of the complex containing more than 10 percent quartz were mapped as quartz monzonite and granite (unit 2a). Good exposures of this unit occur in railway cuts along the east flank of the complex (Photo 5) and it is present as a minor phase on the portage between Shenango and "Long" Lakes. This lithology was originally defined by the author (Thurston *et al.* 1977) as granodiorite on the basis of one thin section prepared from a sample collected from outcrop in a railway cut on the east flank of the complex. This unit displays sharp contacts where it cuts syenodiorite or diorite phases of the complex; in one place it cuts monzonitic phases. The rock is generally fine grained, but in thicker dikes and irregular masses it approaches medium grained. The dikes and masses are leucocratic, and are red, brown-red or deep pink on both weathered and fresh surfaces.

In thin section the rock is dominantly fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The plagioclase in several sections is weakly protoclastic and several thin sections are hypidiomorphic rather than allotriomorphic.

An estimate of the mode is 0 to 35 percent plagioclase (An 2-12), 20 to 30 percent quartz, 0 to 15 percent biotite, and 0 to 80 percent perthite. Two sections contain an estimated 10 percent anhedral to subhedral, green to greenish-brown amphibole. One section contains microcline perthite with well developed string perthite texture.

The plagioclase forms anhedral to subhedral grains of an albite composition. Some plagioclase is weakly saussuritized.

Quartz forms anhedral interlocking grains interstitial to the feldspars.

The perthite is dominantly of the stringy type. Patch perthite, which is usually antiperthite, may have formed by patchy replacement of the plagioclase by potassium feldspar. The perthite grains interlock with the plagioclase grains.

Biotite occurs as brown, anhedral grains that locally are ragged in outline. A trace of poikilitically enclosed zircon with radioactive bombardment haloes was noted in biotite in one thin section.

Trace amounts of sphene, zircon, chlorite, and limonite are present in one or more thin sections.



Photo 5. Sharp contact of quartz monzonite to granite with underlying diorite. The contact is at the end of the hammer handle. Location P- 2.

DIKE ROCKS AND MINOR UNITS

Gabbro

An isolated outcrop of gabbro (unit 2f) occurs on the west side of "Long" Lake. It is uncertain how this rock type relates to the Shenango Township Alkalic Rock Complex.

The rock weathers blue grey to black and is dark grey on fresh surface. The rock is fine to medium grained and massive.

In thin section the rock is fine to medium grained, equigranular, allotriomorphic, with curved to straight grain boundaries. The mode is estimated to be 50 percent plagioclase (An 48-50), 10 percent biotite, 35 percent pyroxene (augite), and 5 percent magnetite. A trace of quartz was noted.

The magnetite forms partially skeletal crystals perhaps after olivine. The biotite is interstitial, interlocks with the magnetite, and forms large, anhedral, ragged grains. Pyroxene forms an interlocking aggregate of grains. Plagioclase is anhedral to subhedral in outline and shows a spotty saussuritization.

Pegmatite Dikes

Pegmatite dikes (unit 2j) were noted at several locations in railway cuts of the Canadian National Railway. These dikes are in sharp contact with diorite to syenodiorite and appear to be gradational into phases of the monzonite to quartz monzonite (Photo 6). The pegmatites are composed mainly of perthite and acicular hornblende. Some hornblende crystals approach 7 to 8 cm in length and the feldspar cleavages are up to be 5 to 7 cm in width.

The pegmatites weather red-brown and are red-brown on fresh surface.

In thin section the rock is coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The mode is estimated as 20 per-

cent amphibole (hornblende), 30 percent plagioclase (An 10–13), and 50 percent perthite. Microcline is present interstitially in one of the pegmatites.

The amphibole is a subhedral, pleochroic, dark green hornblende, likely with high sodium and iron contents.

The perthite is anhedral and dominantly of the string type. Patch antiperthite is present and may have resulted from patchy replacement of the plagioclase.

Plagioclase is of albite to sodic oligoclase composition and displays a weak protoclastic texture in one thin section. Patchy replacement of plagioclase by potassium feldspar is present.

Pegmatite segregations or dikes are common within the complex, but only two were examined in thin section.



Photo 6. Coarse-grained diorite (unit 2c) cut by pegmatitic monzonite dike (unit 2j). Location P-4.

Syenite Dikes

Alkalic syenite dikes (unit 2e) cut outcrops of gneiss on the Canadian National Railway, east of the Shenango Township Alkalic Rock Complex. The relationship of these dikes to the complex is unknown.

These dikes are bright brick-red in colour on fresh and weathered surfaces. Within the largest dike, feldspar phenocrysts up to 1 cm and biotite phenocrysts up to 8 mm in length are present. These phenocrysts are in seriate distribution and comprise less than an estimated 1 percent of the rock. The largest dike is 0.6 m wide, strikes N85W, and dips 22°N.

In thin section, the rock is fine grained, inequigranular, microporphyritic-seriate, and hypidiomorphic. The rock consists of 5 percent phenocrysts of euhedral microcline in a groundmass made up of smaller grains of alkali feldspar displaying a weak trachytic texture. The alkali feldspar groundmass constitutes nearly 80 percent of the rock. Small acicular crystals of amphibole, tentatively identified as arfvedsonite, make up 10 to 15 percent of the rock. Purple fluorite,

constituting up to 1 percent of the rock, occurs as very small grains in the groundmass. Disseminated pyrite makes up approximately 5 percent of the rock. Magnetite, biotite, and sphene occur as accessory minerals.

Minor sericite and kaolinite alteration of the potassium feldspar is common. The bright red-brown colour of the rock may be due to fine-grained, dusty hematite in the feldspar crystal lattices.

A second thin section of the same dike disclosed possible trace amounts of cancrinite. The second section contains no amphibole but contains 25 percent interstitial, anhedral, brown biotite. Weak albite twinning and possible zoning of the feldspars in the groundmass were observed in the second section.

A sample from a smaller dike was thin sectioned. Its texture is fine grained, inequigranular, microporphyritic-seriate, trachytic, and hypidiomorphic. The potassium feldspar microphenocrysts have undergone patchy replacement by carbonate. The trachytic texture is defined by the subparallel orientation of tabular feldspars in the groundmass.

This second dike is 9 cm wide, has a strike of S10W, and dips 70° west. The dike does not appear porphyritic in outcrop.

Plagioclase, Biotite, Porphyritic Syenite Dikes

Several small alkalic dikes (unit 2k), most likely related to the complex were observed in mapping and two were examined in thin section.

A porphyritic syenite dike rock outcrops on the north side of an unnamed lake west of Shenango Lake and a similar dike was noted in a railway cut of the Canadian National Railway.

The dikes are brown-red, green-brown to red-brown in colour and have feldspar phenocrysts up to 4 to 5 mm in maximum size. The phenocrysts comprise 5 to 10 percent of the rocks.

The attitude of the dike at the lake west of Shenango Lake could not be determined. In thin section, this dike rock is fine grained, massive, inequigranular-seriate, allotriomorphic, with curved to lobate grain boundaries. The mode is estimated to be 25 percent anhedral amphibole (hornblende), 25 percent anhedral biotite, and 50 percent irregular, interlocking plagioclase (An 42). The rock is petrographically a diorite aplite. A distinct porphyritic texture is not present in thin section. The megascopic feldspar phenocrysts are gradational with the groundmass plagioclase.

The dike in the railway cut is 40 cm wide, strikes N40E and dips 78° north. This dike also contains biotite phenocrysts up to 3 mm in diameter which may form an estimated 3 to 4 percent of the rock.

In thin section, the dike rock is fine to coarse grained, massive, inequigranular-porphyritic-seriate, and hypidiomorphic. The mode is estimated to be 15 percent brown to green-brown anhedral amphibole (hornblende), 15 percent brown anhedral plagioclase phenocrysts (An 45), 30 percent anhedral plagioclase groundmass, 25 percent perthite, and 3 percent biotite phenocrysts. The plagioclase phenocrysts tend to be glomeroporphyritic, weakly protoclastic, and poikilitically contain inclusions of biotite and amphibole. Euhedral, small apatite crystals are scattered throughout the thin section as inclusions within the feldspar.

Lamprophyre Dikes

A lamprophyre dike (unit 2h) cuts gneissic rocks north of the unnamed lake west of Shenango Lake. The dike weathers black and is black on fresh surface. It is

fine-grained and has small pits 3 to 4 mm in diameter on the weathered surface. The dike is poorly exposed and was not examined in thin section.

PETROLOGY

A group of rock samples (Appendix A, Table A-1) were selected for complete chemical analyses. The rocks selected were the freshest material available and sufficient analyses have been completed on each rock unit to adequately describe the chemistry. The chemical analyses (Appendix A, Tables A-2, A-3) cannot be used to establish silicate liquid trends since protoclastic textures in some units imply that some phases were produced possibly by filter pressing or that they were emplaced as a crystal mush. Diffuse contacts on amphibolitic xenoliths and associated schlieren indicate hybridization of the alkalic magma by assimilation. Samples of such possible hybrid rocks have been rejected for chemical analysis with the possible exception of several samples taken from Kennco Explorations (Canada) Limited drill core.

The compositions of samples of amphibolite (map-unit 1c) were plotted on an AFM diagram (Figure 4a). The amphibolite unit forms a relatively tight cluster towards the FeO-MgO join which reflects its mafic chemistry. The plot indicates a fairly uniform composition. As previously stated, the author does not consider the amphibolite unit to be genetically related to the Shenango Township Alkalic Rock Complex.

The compositions of samples from the quartz monzonite to granite (map-unit 2a) form a cluster towards the alkali corner of the AFM diagram (Figure 4b). This unit is dominantly an aplitic dike rock and its chemistry indicates that it likely formed as a residual melt phase of the Shenango Complex.

The compositions of samples from the monzonite to quartz monzonite (unit 2b), which is the less silica-saturated equivalent of the quartz monzonite to granite map-unit, display a tight clustering along the alkali-FeO join of the AFM diagram (Figure 4c). As with the quartz monzonite to granite, the composition of this unit may reasonably be expected to be equivalent to a late-stage silica melt.

The compositions of samples from the coarse-grained diorite to monzonite (unit 2c) display a linear trend (Figure 4d) on an AFM diagram. The abundant evidence of a protoclastic texture in this map-unit, implying formation by filter pressing or implying that the rocks were emplaced as a crystal mush, would discount the use of these rocks and any chemical trends to postulate silica melt composition.

An AFM plot of the compositions of samples from the diorite to monzonite (unit 2d) indicates a cluster of data towards the center of the diagram (Figure 4e). The clustering of the data implies the possibility that this rock unit could be a melt equivalent. The fact that rocks of this unit appear brecciated and veined in places, with coarse-grained felsic pegmatitic material likely representing a residuum from the host rocks, would mean caution is needed in that assumption.

The compositions of samples of three monzonite pegmatite dikes have been plotted on an AFM diagram (Figure 4f). The dike rocks plot on or close to the alkali-FeO join.

Norms, calculated by the methods of Irvine and Baragar (1971), are presented in Appendix A, Table A-4. The norms are only for comparative purposes since some units are likely to have been emplaced as crystal mushes or were formed by a process of filter pressing, and their compositions are not likely melt equivalents.

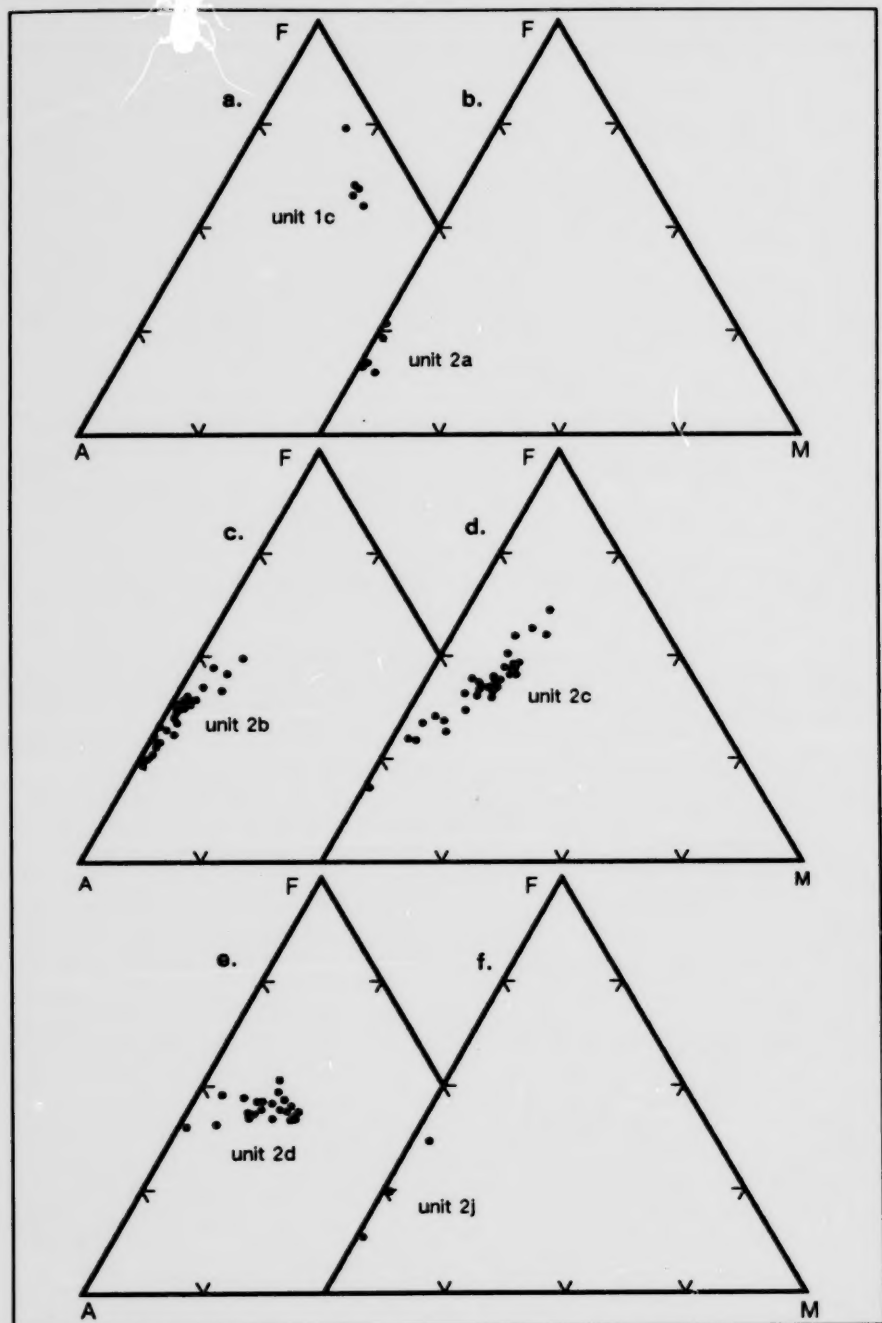


Figure 4. AFM plots of samples from the Shenango Township Alkalic Rock Complex. a. Amphibolite, unit 1c. b. Quartz monzonite to granite, unit 2a. c. Monzonite to quartz monzonite, unit 2b. d. Coarse-grained diorite to monzonite, unit 2c. e. Diorite to monzonite, unit 2d. f. Monzonite pegmatite dikes, unit 2j. A = Na_2O ; F = FeO (total); M = MgO.

The chemical analyses for each lithologic map-unit have been analyzed statistically (Appendix A, Table A-5) using the methods of Nie *et al.* (1975).

GEOCHRONOLOGY

K. Bell and D.H. Watkinson (Carleton University, unpublished data, 1972) completed K-Ar isotopic age determinations (Table 8) on biotite-bearing drill core of Kennco Exploration (Canada) Limited.

L. Owen (Ohio State University, personal communication, 1972) obtained an Rb-Sr isochron age of 1099.7 ± 184.6 Ma on samples collected by the author during Operation Chapleau (Thurston *et al.* 1977). Figure 5 is the isochron obtained by Owen (1972).

Bell and Blenkinsop (1980) obtained a Rb-Sr isochron age of 1047 ± 15 Ma on samples collected by the author from the Shenango Township Alkalic Rock Complex.

The isotopic ages are, within experimental error, equivalent to other isotopic ages of carbonatite-alkalic complexes within the Kapuskasing Subprovince (Gittins *et al.* 1967) and imply that rocks of this complex are intimately related to other alkalic intrusive events within this subprovince.

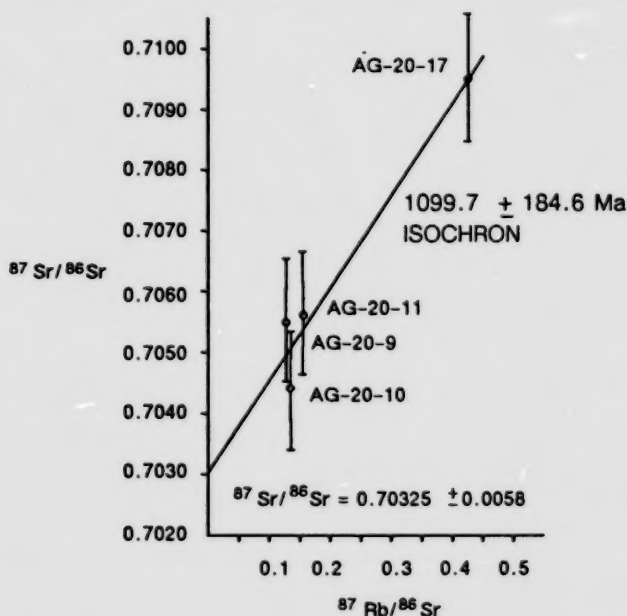


Figure 5. Rb/Sr isochron plot of samples from the Shenango Township Alkalic Rock Complex. Isochron from L. Owen, unpublished data, 1972. (Work completed under direction of G. Faure, Laboratory for Isotope Geology and Geochemistry, Ohio State University.) Standard deviation of $^{87}\text{Sr}/^{86}\text{Sr}$ is ± 0.0010 .

TABLE 8. K-AR (BIOTITE) ISOTOPIC AGES FROM THE SHENANGO TOWNSHIP ALKALIC ROCK COMPLEX (BELL AND WATKINSON, CARLETON UNIVERSITY, UNPUBLISHED DATA, 1972).

Hole	Depth	K-Ar Age
K-1	496.0 feet	1076 $\pm$ 42 Ma 1082 $\pm$ 24 Ma
K-2	306.0 feet	1065 $\pm$ 24 Ma

METAMORPHISM

On the basis of regional reconnaissance studies the rocks enclosing the Shenango Township Alkalic Rock Complex have been metamorphosed to the granulite facies rank of regional metamorphism (Thurston *et al.* 1977).

The rocks comprising the Shenango Township Alkalic Rock Complex and intruding the granulite grade rocks are unmetamorphosed. Patch perthite textures or potassium replacement of plagioclase are common in thin sections prepared from alkalic rocks of the complex. This replacement feature is considered by the author to be a late stage deuteric or autometamorphic event related to emplacement and consolidation of the alkalic rocks. The amphibole and biotite replacements of pyroxene, common in the coarse-grained diorite to monzonite map-unit, are also considered by the author to have formed during a late-stage magmatic process and not during an independent metamorphic event.

The amphibolite map-unit was likely metamorphosed before inclusion into the alkalic rock magma. The regional metamorphism of this unit has been overprinted by a hornblende hornfels facies of contact metamorphism at the time of alkalic rock emplacement.

Diffuse contacts on amphibolite xenoliths and associated schlieren within the alkalic rocks, and local higher mafic content in the alkalic rocks in proximity to the amphibolite-alkalic rock contacts suggest local hybridization of the alkalic magma. To effect the hybridization, a temperature was required sufficient to mobilize the felsic components within the amphibolite, leaving the more resistant mafic minerals to contaminate the hybridized alkalic magma.

STRUCTURAL GEOLOGY

REGIONAL SETTING

The Shenango Township Alkalic Rock Complex lies within the Kapuskasing Sub-province of the Superior Province.

The alkalic rocks are unmetamorphosed and undeformed in contrast to the amphibolites within the complex and the granulite-facies rocks surrounding the complex. The lack of deformation and metamorphism implies that the rocks were post-kinematically emplaced into the highly metamorphosed and folded host rocks. Several outcrops interpreted as metagabbro and garnet-bearing metagabbro occur along the east and south flanks and appear similar to outcrops of the Archean Shawmere Anorthosite Complex (Thurston *et al.* 1977). Tentatively, the Shenango Township Alkalic Rock Complex may represent a series of alkalic rocks emplaced as concordant intrusions in a fold structure within gneissic rocks bordering the Shawmere Anorthosite Complex.

INTERNAL STRUCTURES

In general, foliation trends of the gneissic wall rocks in proximity to the complex appear conformable to the outline of the complex, supporting the interpretation

that the complex was emplaced into folded gneissic rocks. A weak trachytoidal texture is present in the coarse-grained diorite to monzonite map-unit. This texture is defined by a weak subparallel orientation of the tabular feldspar crystals. A weak, diffuse mafic segregation banding was noted in several outcrops. The above features, which can be measured, are generally oriented conformable to the outline of the complex.

Within the fine-grained diorite to monzonite map-unit, monzonite and quartz monzonite diking are locally so pervasive as to give the outcrop a brecciated appearance. Dikes of these compositions, with one possible exception, do not cut the gneisses, implying that there was a close relationship between emplacement, brecciation, and intrusion of the later more alkali-rich, silica-rich monzonitic rocks. Simple segregation of a felsic residue was not likely the mechanism of dike formation since the dikes display sharp non-gradational contacts with host diorite to syenodiorite. The dikes may represent allochthonous intrusions of late stage, silica-rich liquids into a largely consolidated host rock which had undergone fracturing due to late tectonic activity. These late-stage, silica-rich liquids were genetically related to the Shenango Township Alkalic Rock Complex, but had moved from their place of origin into dilatant fractures during the terminal phase of emplacement.

The excellent and pervasive protoclastic texture found in the coarse-grained diorite to monzonite map-unit is a primary textural feature. This texture likely formed at the time of emplacement due to filter pressing of the crystallizing diorite to monzonite magma. The pervasive presence of erratically trending dikes of quartz monzonite to granite and monzonite to quartz monzonite, cutting the protoclastic textured diorite but not the gneissic wall rocks, implies a close genetic relationship between these map units. They may represent the decanted residual liquids of a filter-pressed alkalic diorite magma that had undergone crystal fractionation processes.

The presence of roof pendants and xenoliths of amphibolitic wall rocks in combination with minor but abundant intergranular myrmekite in some of the dominant lithologies implies that the intrusion is exposed at a relatively high level.

The amphibolite band likely represents a distinct unit in a folded Archean gneissic suite which was engulfed by the intruding alkalic magma. Ring fracturing and faulting and caldera-style subsidence likely accompanied intrusion.

MAGNETIC RESPONSE

The original interpretation that the Shenango area was underlain by an alkalic rock complex was based on a circular aeromagnetic anomaly detected by regional airborne geophysical surveys (Satterly 1968, ODM- GSC 1963). Ground investigation has indicated that the anomaly is caused by minor amounts of magnetite in a curvilinear amphibolite unit which is likely not related to the alkalic rock complex. The horseshoe-shaped form of this unit suggests that the emplacement of alkalic rocks may have been into a fold structure in the gneissic host rocks. This intrusion has ruptured the fold which, on the basis of regional geology, may have been located in proximity to the north contact of the Shawmere Anorthosite Complex.

Compilation of ground geophysical data by Kennco Explorations (Canada) Limited on the southern portion of the complex reveals two crudely circular patterns (Figure 6) which suggest that there may have been two intrusive centres. A third centre may be located on Shiners Lake. Ground data is insufficient to clearly outline or define the three possible centres of magma emplacement.

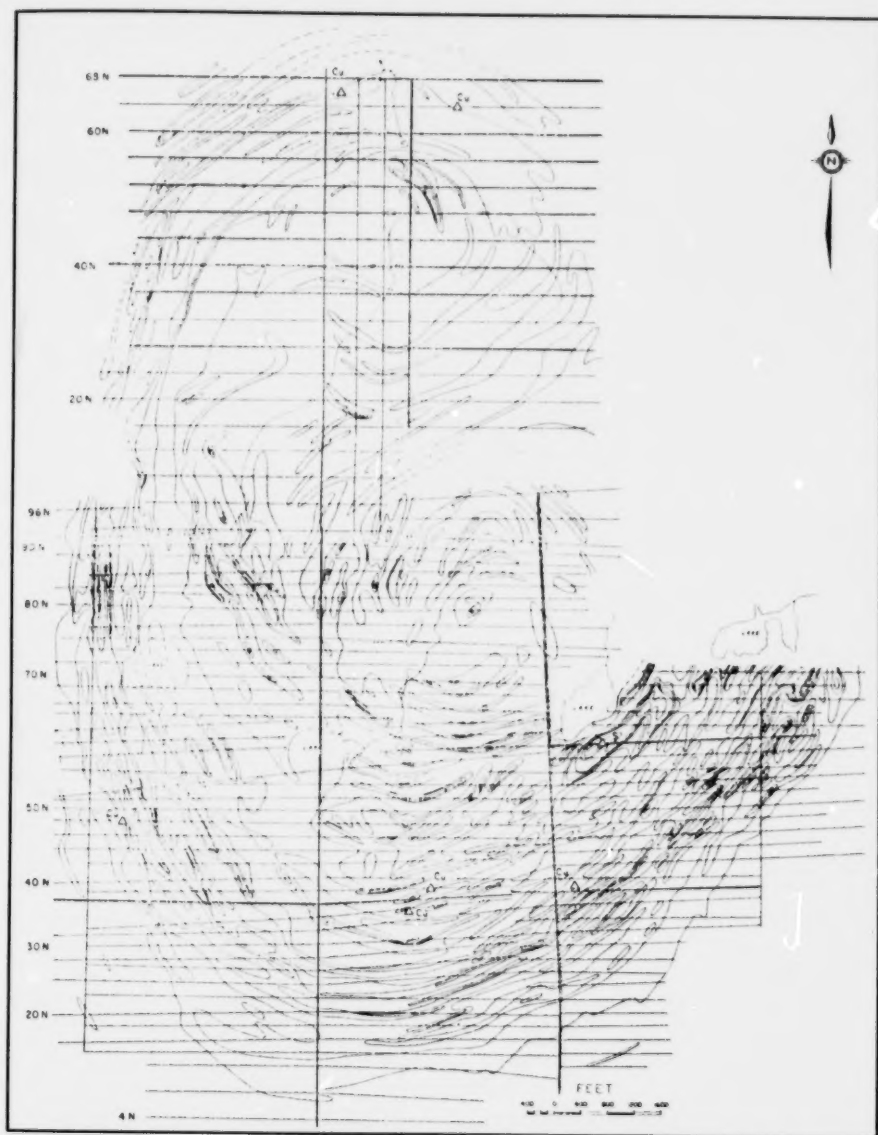


Figure 6. Magnetic data compiled from ground surveys by Kennco Explorations (Canada) Limited. Note circular pattern in northern and central portions of the surveyed area.

RECOMMENDATIONS FOR FUTURE STUDY

Mapping to date of the Shenango Township Alkalic Rock Complex has been partly reconnaissance in nature. Detailed mapping (scale 1:15,840) is incomplete and the accompanying map is in part interpretive. To complete detailed mapping, additional traversing is needed east, northeast, and southwest of Shiners Lake; in the area of "Barry" Lake (local name); and north to northwest of "Fork" Lake (local name). Mapping of several areas south and southwest of the tracks of the

Canadian National Railway towards "Bollo" and "Cone" Hills is needed to better define the structure and lithologic distribution.

The various mineral phases should be examined with a universal stage and limited additional microprobe analyses may be advisable. The petrographic descriptions accompanying this report are based on only a very brief examination of the thin sections, largely prepared from samples submitted for chemical analysis.

Economic Geology

Mapping by members of the field party failed to locate sulphide mineralization in rocks of the complex, but confirmed the presence of minor pyrite mineralization in the amphibolites. The sulphide content is generally low. The amphibolite is highly metamorphosed and likely of Early Precambrian age and thus not related to the alkalic rocks of the complex which are Late Precambrian in age. The amphibolite unit is likely a remnant of a former western extension of the Belford-Strachan metavolcanic-metasedimentary belt which has been described by Bennett (1969).

Rocks containing visually identifiable apatite or nepheline were not seen.

Rocks of the ijolite series, which commonly contain niobium mineralization in alkalic rock-carbonatite complexes, were not encountered. Carbonatite was not found and evidence for fenitization of the host rocks characteristic of carbonatite intrusions was not observed.

The rock suite represents a silica-saturated to over-saturated series and lacks the lithologies that are known to be associated with economically interesting mineralization in other alkalic complexes.

PROPERTY DESCRIPTIONS

Genesco Resources Limited [1969]

In 1968 and 1969, Genesco Resources Limited completed line cutting, prospecting and a geological survey and magnetometer survey over the central portion of the complex. This work failed to disclose anything of interest.

Kennco Explorations (Canada) Limited [1970]

Kennco Explorations (Canada) Limited in 1970 completed line cutting over the northern portion of the complex and re-examined some of the area covered by Genesco Resources Limited. This work disclosed some sulphide mineralization containing copper values in the arcuate amphibolitic unit within the interior of the complex. These showings were not judged by the company to be worth follow-up work.

The company completed a magnetometer survey and induced polarization survey over portions of the property. Two diamond drill holes totalling 1006 feet were drilled by the company in the northern portion of the complex. The holes encountered amphibolitic and monzonitic rocks, but were barren of economic mineralization and the company terminated its activity in the area.

International Minerals and Chemical Corporation (Canada) Limited [1974]

Representatives of the International Minerals and Chemical Corporation (Canada) Limited examined portions of the complex in 1974 but were not encouraged and suspended further activity (International Minerals and Chemical Corporation (Canada) Limited, files donated to Assessment Files Research Office, Ontario Geological Survey, Toronto).

RECOMMENDATIONS TO THE PROSPECTOR

Sulphide mineralization or mineralization of the type found in other nearby alkalic complexes that would be of potential economic interest was not observed

by the field party. The Shenango Township Alkalic Rock Complex represents a more silica-saturated series of rocks than those found in other nearby alkalic rock complexes of similar age. This fundamental difference in rock chemistry compared to the other alkalic rock complexes found within the Kapuskasing Sub-province is not encouraging for the location of similar mineralization. Greater economic potential would appear to lie in the gneissic rocks, both within and outside the complex, rather than in the alkalic rocks themselves.

Appendix A

Petrographic Descriptions, Chemical Analyses, Normative Compositions, And Statistical Compositions Of Lithologic Units Of The Shenango Township Complex

TABLE A-1. PETROGRAPHIC AND FIELD DESCRIPTIONS OF WHOLE-ROCK SAMPLES FROM THE SHENANGO TOWNSHIP COMPLEX

Map No. 548

Sample No. SHR 1-1

Pyroxene - amphibole - biotite diorite.

Field Description. Fine-grained, massive, equigranular. Colour index approximately 40. Outcrop is cut by biotite-feldspar dikes displaying sharp contacts. Weathered surface brownish-red, fresh surface reddish-black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene (augite) is anhedral in form, and mantled with patches of green amphibole. Anhedral grains of hornblende are green to greenish-brown. Amphibole commonly has relict pyroxene in core of grain. Biotite forms anhedral, brown grains. Apatite forms euhedral, poikilitic grains in biotite. Pyroxene and plagioclase (An40-42) form an anhedral, interlocking mosaic.

Map No. 549

Sample No. SHR 1-7

Perthite-bearing, pyroxene - amphibole - biotite diorite.

Field Description. Medium grained, equigranular, massive. Colour index 35 to 40. Weathered surface is mottled buff and black; fresh surface is black and buff. Rock is finer-grained phase of map-unit 2c or coarser-grained phase of map-unit 2d.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene (augite) is extensively altered to amphibole. Amphibole (hornblende) forms pleochroic greenish to yellowish-green grains often with relict pyroxene cores. Perthite is anhedral, interstitial, and stringy. Biotite forms anhedral, brown grains associated with amphibole. Plagioclase forms anhedral to subhedral grains with abundant saussuritization, particularly in core of crystals. Apatite is euhedral and poikilitic in biotite and amphibole.

Map No. 550

Sample No. SHR 51-18B

Syenite pegmatite.

Field Description. Coarse grained, massive, equigranular. Pegmatite forms a 4 m wide dike cutting medium- to coarse-grained diorite. Weathered and fresh surfaces are red. Map-unit 2j.

Petrographic Description. Coarse grained, equigranular, massive, hypidiomorphic. Amphibole is dark green, subhedral, and sodic. Its extinction angle is

higher than for normal hornblende. Plagioclase (An₁₂) has undergone patchy potassium replacement; microcline is interstitial to other feldspars. String perthite forms large, anhedral grains, which rarely engulf grains of plagioclase. Feldspar grain boundaries are lobate.

Map No. 551

Sample No. SHR 29-2A

Monzonite aplite.

Field Description. Fine grained, massive, equigranular. Veined by syenodiorite; contacts are sharp. Weathered and fresh surfaces are red. Map-unit 2a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Quartz is anhedral and interstitial. Plagioclase (An₆₋₁₁) grains are anhedral to subhedral with weak protoclastic texture. Biotite occurs as brown, anhedral grains. Amphibole (hornblende) forms green to brownish-green, subhedral grains. Microcline forms anhedral, interlocking grains with well developed quadrille twinning. Microcline is interstitial to plagioclase.

Map No. 552

Sample No. SHR 29-2B

Biotite - amphibole syenodiorite.

Field Description. Fine grained, equigranular, massive. The outcrop is veined with monzonite dikes. A monzonite dike was removed from the sample by diamond saw before analysis to obtain accurate results. Colour index 45. Weathered and fresh surfaces are mottled pink and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Biotite forms anhedral, irregular, brown grains. Amphibole (hornblende) forms anhedral, green to yellowish-green grains, irregular or ragged in outline with relicts of augitic pyroxene. Pyroxene occurs only as relicts within amphibole. Perthite and microcline are interstitial to plagioclase. Perthite is stringy. Plagioclase (An₅₀₋₅₄) forms anhedral, interlocking grains with spotty saussuritization.

Map No. 553

Sample No. SHR 29-3

Biotite - amphibole monzonite.

Field Description. Fine grained, massive, equigranular. The rock is veined with quartz monzonite. Colour index 35 to 45. Weathered surfaces are pink and black, fresh surfaces speckled pinkish-red and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite forms tiny, needle-like crystals poikilitic in feldspar amphibole and biotite. Amphibole (hornblende) is greenish-brown to yellowish-brown, and anhedral. Biotite forms brown, anhedral grains. Potassium feldspar consists of anhedral and interstitial microcline and cryptoperthite. Plagioclase (An₄₀₋₄₃) forms an interlocking mosaic of anhedral grains.

Map No. 554

Sample No. SHR 29-9

Biotite - pyroxene diorite.

Field Description. Fine grained, massive, equigranular. Fractures filled with fine-grained, leucocratic quartz monzonite cut the outcrop. One quartz monzonite

dike contains a miarolitic cavity, 1 cm in diameter. The weathered surface of the rock is grey-black, the fresh surface is reddish black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Pyroxene (augite) forms anhedral, irregular grains. Apatite forms euhedral, poikilitic grains in feldspar. Biotite forms brown, anhedral grains. Plagioclase (An41) forms an interlocking mosaic of anhedral grains.

Map No. 555

Sample No. SHR 29-12A

Pyroxene - biotite - amphibole monzonite.

Field Description. Fine grained, massive, equigranular. Locally there is some coarsening of grain size. Weathered and fresh surfaces are mottled pink to red and black. The outcrop is cut by medium-grained monzonite. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Amphibole forms anhedral, irregular grains and mantles on pyroxene. Amphibole is pleochroic in brown and green. Biotite forms anhedral, brown to greenish-brown, irregular grains. Pyroxene (augite) forms anhedral, relict grains mantled with amphibole. Apatite is euhedral and poikilitic in amphibole, biotite and plagioclase. Perthite is anhedral and interstitial, possibly a cryptoperthite. Plagioclase (An32-34) forms anhedral to euhedral grains, which are weakly saussuritized, weakly zoned, and rarely have myrmekite along grain boundaries.

Map No. 556

Sample No. SHR 29-12B

Amphibole - biotite monzonite.

Field Description. Medium grained, equigranular, massive. Slightly coarser phases imply some pegmatitic development. Colour index approximately 25. Fresh and weathered surfaces are mottled red and black. Map-unit 2b.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic with curved to lobate grain boundaries. Biotite forms fine-grained, anhedral, crystal aggregates replacing former mafics, possibly amphibole. Amphibole as anhedral brown to greenish-brown grains occurs in association with biotite. Patch and stringy perthite forms anhedral, irregular grains. Plagioclase (An9) forms anhedral grains with protoclastic textures and patchy potassium feldspar replacement.

Map No. 557

Sample No. SHR 29-12C

Quartz monzonite.

Field Description. Fine grained, massive, equigranular. Quartz visible. The rock cuts syenodiorite of map-unit 2d. The sample was taken from an aplitic dike. Weathered and fresh surfaces are red. Map-unit 2a.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Quartz forms anhedral, interstitial grains. Minor biotite forms anhedral to subhedral grains. Anhedral to subhedral grains of patchy antiperthite (An8-12) show patchy saussuritization.

Map No. 558**Sample No. SHR 29-12F**

Biotite – amphibole syenodiorite.

Field Description. Fine grained, equigranular massive. Colour index approximately 40. Fresh and weathered surfaces are mottled red and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene forms only minor relict grains replaced by amphibole and biotite. Amphibole (hornblende) forms green to brownish green, euhedral to subhedral grains. Biotite forms brown, anhedral to subhedral, irregular grains interlocking with amphibole. Plagioclase (An38?) forms anhedral to subhedral grains. Some grains display concentric zoning with saussuritized cores. Cryptoperthite is interstitial to plagioclase.

Map No. 559**Sample No. SHR 29-13**

Amphibole – pyroxene – biotite diorite.

Field Description. Fine grained, equigranular, massive. Outcrop is veined with monzonite; contacts are sharp. Some monzonite is quartz-bearing. Weathered surfaces are mottled pink and black; fresh surfaces are mottled red and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene (augite) forms anhedral grains, locally altering to a greenish hornblende; alteration forms rims on the pyroxene and patches within the pyroxene. Amphibole (hornblende) forms anhedral, green to greenish-brown crystals, in part, an alteration of pyroxene. Biotite forms brown, anhedral crystals interlocking with other mafic minerals. Anhedral to subhedral grains of plagioclase (An39) form an interlocking mosaic. Spotty saussuritization appears on larger plagioclase crystals.

Map No. 560**Sample No. SHR 29-15**

Gabbro.

Field Description. Medium grained, massive, equigranular. Colour index 40 to 50. Weathered surfaces are blue-grey to black, fresh surfaces are dark grey-black. Map-unit 2h.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Magnetite forms skeletal crystals perhaps after olivine. Biotite forms interstitial grains, interlocking with magnetite, possibly after olivine. Pyroxene is augite, and forms a polycrystalline, interlocking aggregate of grains which are commonly replaced by brown biotite. Most biotite in the section is likely replacing pyroxene. Plagioclase (An48-50) forms anhedral to subhedral grains with some spotty saussuritization. The sample is weakly protoclastic.

Map No. 561**Sample No. SHR 36-8**

Quartz monzonite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index 40 to 45. Outcrop is weakly foliated. Weathered surface is pinkish grey and fresh surface is mottled pinkish grey and black. Map-unit 2c.

Petrographic Description. Medium to coarse grained, massive, equigranular, hypidiomorphic. Pyroxene forms relicts within amphibole. Biotite forms anhedral grains with bent (001) cleavage. Amphibole is greenish brown to brown hornblende with rare relict pyroxene cores. Myrmekite forms irregular amoeboid interstitial grains. String perthite occurs as large irregular grains and has local areas with vestiges of albite twinning. Plagioclase (An28–30) forms anhedral irregular grains of generally smaller size than the perthite grains. Feldspars form an interlocking mosaic.

Map No. 562

Sample No. SHR 36–9

Pyroxene – amphibole – biotite syenodiorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 40. Weathered surface pinkish brown, fresh surface mottled pink and black. Map–unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Relict grains of pyroxene (augite) are anhedral and mantled with amphibole and biotite. Amphibole (hornblende) forms green to brownish green grains, sometimes replacing pyroxene. Biotite occurs as brown anhedral grains with bent (001) cleavage. Perthite occurs as anhedral interstitial grains with stringy perthite texture. Plagioclase (An32–40) forms anhedral to subhedral interlocking grains with well-developed protoclastic texture.

Map No. 563

Sample No. SHR 38–3

Biotite – amphibole monzonite.

Field Description. Medium to coarse grained, equigranular, massive. Colour index approximately 35. Several fine-grained amphibolitic inclusions are present. Weathered and fresh surfaces are mottled pinkish buff and black. Map–unit 2c.

Petrographic Description. Medium to coarse grained, massive, equigranular, hypidiomorphic, protoclastic. Perthite forms anhedral, irregular, interstitial grains. Plagioclase (An30–34) forms anhedral to euhedral crystals, weakly saussuritized along fractures. Biotite forms anhedral crystals interlocking with amphibole. Amphibole is anhedral to subhedral, brown to greenish-brown hornblende. Apatite forms euhedral crystals poikilitic in amphibole and biotite.

Map No. 564

Sample No. SHR 38–4

Granodiorite aplite.

Field Description. Fine grained, massive, equigranular aplitic dike rock. The dike is 1.5 m wide and cuts medium- to coarse-grained diorite. Weathered and fresh surfaces are red. Map–unit 2a.

Petrographic Description. Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. String perthite to cryptoperthite forms an interlocking mosaic with plagioclase. Perthite is locally turbid and/or clouded. Plagioclase (An2–12) has locally undergone patchy replacement by potassium feldspar. Quartz is anhedral and interstitial to feldspar.

Map No. 565**Sample No. SHR 38-5B**

Biotite - amphibole syenodiorite.

Field Description. Medium to coarse grained, equigranular. Colour index 30 to 35. Weathered and fresh surfaces are mottled pink and black. A cataclastic zone was removed from the sample before analysis. Some gneissic wall rock occurs on one end of the outcrop. The sample itself is weakly foliated. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Anhedra, irregular grains of string perthite occur interstitially. Plagioclase (An₃₅) forms anhedra to subhedra grains with spotty saussuritization. Amphibole (hornblende) forms anhedra, green to greenish-brown grains. Biotite forms anhedra brown grains associated with amphibole and interlocking with each other.

Map No. 566**Sample No. SHR 49-1**

Biotite - amphibole gabbro.

Field Description. Fine to medium grained, massive, equigranular. Weathered surfaces are rusty brown; fresh surfaces are mottled pink and black. The outcrop is cut by leucocratic, feldspar-rich stringers. Amphibolitic xenoliths occur in one corner of outcrop. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene (augite) forms anhedra to subhedra grains with extensive patchy replacement. Amphibole (hornblende) occurs as light green alteration of the pyroxene. Biotite forms ragged, anhedra brown grains. Apatite is euhedra, poikilitic in feldspar, pyroxene and biotite.

Map No. 567**Sample No. SHR 49-3A**

Quartz-bearing, amphibole - olivine monzonite.

Field Description. Very fine grained, equigranular, massive. The outcrop is diked with monzonite and quartz monzonite. Contacts with dikes are generally sharp. Weathered and fresh surfaces are pinkish black. Possibly the sample represents a chilled phase. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Quartz is anhedra and interstitial. Olivine forms anhedra, irregular grains, possibly fayalite. Amphibole (hornblende) is green to yellowish-green with traces of relict pyroxene. Plagioclase (An₃₂₋₃₄) forms an interlocking mosaic of anhedra grains. Anhedra grains of stringy perthite interlock with plagioclase.

Map No. 568**Sample No. SHR 49-3B (not analysed)**

Biotite quartz monzonite.

Field Description. Fine to medium grained, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 4 mm in seriate distribution make up 5 to 10 percent of rock. Visible quartz. Rock cuts syenodiorite of map unit 2d. Weathered and fresh surfaces are red. Map-unit 2a.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Quartz forms anhedral, interstitial grains. Biotite forms irregular, anhedral grains. Plagioclase (An4-7) forms euhedral to subhedral grains. Perthite forms anhedral, irregular grains with both stringy and patchy texture.

Map No. 569

Sample No. SHR 49-3C

Pyroxene diorite.

Field Description. Fine grained, massive, equigranular. The outcrop is extensively diked with monzonite and quartz monzonite. Colour index approximately 45. Weathered and fresh surfaces are finely speckled pink and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Apatite forms tiny, euhedral crystals in biotite and pyroxene. Pyroxene (augite) forms anhedral, interstitial grains which are locally weakly zoned. Biotite forms anhedral, irregular grains which may partially enclose pyroxene and plagioclase. Plagioclase (An43-51) forms anhedral, irregular grains. Weak protoclastic textures are present in larger grains.

Map No. 570

Sample No. SHR 49-3D

Pyroxene diorite.

Field Description. Medium grained, equigranular, massive. Veins of syenodiorite are locally so pervasive as to give the outcrop the appearance of an intrusive breccia. Colour index 5 to 10. Weathered and fresh surfaces are buff. Map-unit 2a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Apatite forms tiny, euhedral crystal in biotite and pyroxene. Pyroxene (augite) forms anhedral, interstitial grains, sometimes weakly zoned. Biotite forms anhedral, irregular grains which may partially enclose pyroxene and plagioclase. Plagioclase (An43-51) forms anhedral, irregular grains. Weak protoclastic textures are present in larger grains.

Map No. 571

Sample No. SHW 50-10

Perthite-bearing, biotite - pyroxene diorite.

Field Description. Medium grained, massive, equigranular. Colour index 40. Weathered and fresh surfaces are pinkish grey. Rock is possibly a slightly coarser-grained phase of map-unit 2d.

Petrographic Description. Fine grained, equigranular, allotriomorphic, with curved to straight grain boundaries. Plagioclase (An36) forms subhedral to euhedral grains; some display protoclastic textures. Pyroxene (augite) forms anhedral to euhedral grains, in part replaced by amphibole. Hornblende rims and replaces pyroxenes. Biotite forms anhedral, irregular, brown grains interlocking with pyroxene. Perthite forms anhedral, interstitial grains.

Map No. 572

Sample No. SHR 51-2B

Pyroxene - biotite diorite.

Field Description. Fine grained, massive, equigranular, hypidiomorphic. Outcrop is veined with aplitic dikes. Weathered surfaces are pinkish grey; fresh surfaces are reddish brown. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Plagioclase (An38) is anhedral to subhedral in outline with protoclastic textures. Biotite forms anhedral to subhedral, brown grains with bent (001) cleavage planes. Pyroxene (augite) is enclosed in biotite and in places displays patchy green alteration to green amphibole. Apatite is euhedral and poikilitic in biotite and pyroxene.

Map No. 573

Sample No. SHR 51-10

Pyroxene – biotite syenodiorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 40. Outcrop is cut by fine-grained aplite dikes. Weathered and fresh surfaces are mottled pinkish grey and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Plagioclase (An35–45) forms anhedral to subhedral grains with protoclastic texture. One large grain is zoned from An52 at the core to An34 at the rim. Pyroxene is augite, ragged, anhedral in outline. Biotite forms brown, irregular, anhedral crystals, ragged in outline, with bent (001) cleavage. Perthite forms anhedral, irregular, interstitial grains. Apatite is euhedral and poikilitic in biotite and pyroxene.

Map No. 574

Sample No. SHR 51-18A

Biotite – amphibole syenite.

Field Description. Fine grained, massive, equigranular. Sample was taken from a dike approximately 6 m wide and closely associated with coarse-grained pegmatite. The dike rock cuts medium- to coarse-grained diorite. Weathered and fresh surfaces are red. Map-unit 2j.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite forms anhedral, brown grains interstitial to feldspars. Amphibole is anhedral to subhedral, brown to greenish-brown hornblende. Microcline forms anhedral, interlocking, interstitial grains with patchy vestiges of perthitic texture. Stringy perthite forms anhedral grains. Plagioclase (An12?) forms anhedral, irregular grains interlocking with and sometimes enclosing microcline.

Map No. 576

Sample No. SHR 51-37

Pyroxene – amphibole – biotite monzonite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index 35. Weathered and fresh surfaces are buff and black. The outcrop is cut by hornblende-feldspar pegmatite and fine-grained aplite. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Amphibole (hornblende) forms a green to yellowish-green alteration of pyroxene. Apatite is euhedral and poikilitic in pyroxene and biotite. Perthite forms anhedral, interlocking grains with stringy perthite. Plagioclase (An33) forms anhedral to subhedral grains with protoclastic texture. Biotite forms brown interlocking grains with bent (001) cleavage.

Map No. 577

Sample No. SHR 51-40

Diorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index 30 to 35. Weathered and fresh surfaces are mottled buff and black. Map-unit 2c.

Petrographic Description. Coarse grained, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene is colourless augite with poikilitic apatite. Pyroxene commonly is relict with mantles of amphibole and biotite. Amphibole is brown to greenish-brown in colour, and generally occurs as a corona to pyroxene. Biotite rims pyroxene and amphibole and occurs dominantly as large, anhedral, brown grains.

Map No. 578

Sample No. SHR 51-43

Diorite

Field Description. Coarse grained, massive, equigranular. The outcrop is cut by coarse-grained hornblende-biotite pegmatite and red aplite. Weathered surfaces are mottled buff and greenish-black. Map-unit 2c.

Petrographic Description. Coarse grained, massive, equigranular, hypidiomorphic. Pyroxene (augite) grains are colourless and subhedral, and contain poikilitic apatite. Biotite occurs in association with and rarely has replaced pyroxene. Biotite commonly has bent (001) cleavage planes. Plagioclase (An34-38) forms an interlocking mosaic with well-developed protoclastic texture.

Map No. 579

Sample No. SHR 51-50A

Diorite

Field Description. Medium to coarse grained, massive. The rock is cut by very coarse-grained hornblende-feldspar pegmatite and fine-grained aplite. Colour index 30 to 35. Weathered surfaces are grey and black, fresh surfaces are pinkish grey and black. Map-unit 2c.

Petrographic Description. Coarse grained, massive, equigranular, hypidiomorphic. Pyroxene is a colourless augite with subhedral to euhedral outline and poikilitic inclusions of apatite. Biotite forms large, anhedral grains commonly in association with pyroxene. Plagioclase (An40-54) forms an interlocking aggregate of grains displaying bent and fractured grains. Protoplastic textures are well developed.

Map No. 580

Sample No. SHR 51-52

Perthite-bearing, amphibole - biotite diorite.

Field Description. Medium to coarse grained, massive, equigranular. The outcrop is cut by coarse-grained pegmatite stringers and fine-grained aplite. Weathered surfaces are mottled pinkish buff and black; fresh surfaces are pink and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic with straight to curved grain boundaries. Perthite is anhedral and interstitial.

Perthite has a weak stringy texture. Plagioclase (An38-40) forms an interlocking mosaic of anhedral to subhedral grains. Biotite forms anhedral, brown grains, some with bent (001) cleavage. Amphibole (hornblende) forms anhedral, brown grains pleochroic in green and yellow brown. Rarely, pyroxene (augite) relict cores are present in some amphibole grains. Apatite is euhedral and poikilitic in biotite, amphibole, and pyroxene.

Map No. 581

Sample No. SHR 51-54

Syenite aplite.

Field Description. Fine grained, equigranular, massive dike cutting medium- to coarse-grained diorite. Colour index approximately 15. Dike is 1 m wide. Weathered and fresh surfaces are pinkish red. Map-unit 2b.

Petrographic Description. Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Amphibole is dark green to greenish brown hornblende, subhedral to anhedral in outline. Microcline is anhedral and interstitial. Perthite is a string type, locally almost patchy. Some grains are cryptoperthite. Plagioclase (An9) is anhedral and forms an interlocking mosaic with other feldspars.

Map No. 582

Sample No. SHR 51-54B

Diorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index 35 to 40. The outcrop is cut by hornblende monzonite pegmatite. Weathered and fresh surfaces are mottled pink and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene of augite composition is uncommon and occurs as relicts in amphibole. Amphibole is green to greenish brown anhedral hornblende. Biotite forms large, irregular grains in association with amphibole. Some biotite has bent (001) cleavage planes. Plagioclase (An40-46) forms an interlocking mosaic of grains with well-developed protoclastic texture. Bent albite twin planes and fracturing are common.

Map No. 583

Sample No. SHR 51-55

Quartz-bearing, syenite aplite.

Field Description. Fine to medium grained, massive, equigranular. The sample was taken from a small (9 cm wide) dike cutting medium- to coarse-grained diorite. Weathered and fresh surfaces are red. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Amphibole is green to dark green anhedral hornblende, likely sodic. Potassium feldspar occurs as patchy replacement of plagioclase (An7). Perthite is a crude string perthite. Feldspar grains form a crude, interlocking mosaic. Quartz occurs interstitially.

Map No. 584

Sample No. SHR 51-55B

Syenodiorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index 35 to 40. Weathered and fresh surfaces are mottled pinkish buff and black.

The outcrop is cut by coarse-grained pegmatite and fine-grained aplite. Map-unit 2d.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Apatite forms euhedral, poikilitic grains in pyroxene, amphibole, and biotite. Pyroxene forms clear, colourless grains mantled with amphibole and biotite. Amphibole is dark brown, commonly mantles pyroxene, and may be associated with biotite. Biotite forms anhedral grains replacing or mantling pyroxene and amphibole. Larger grains locally display bent (001) cleavage. Plagioclase (An43-45) forms anhedral to euhedral crystals which show spotty saussuritization and are weakly protoclastic. Orthoclase is interstitial to plagioclase and anhedral in form.

Map No. 585

Sample No. SHR 51-55D

Syenodiorite.

Field Description. Medium grained, massive, equigranular. This phase cross-cuts a medium- to coarse-grained phase. Colour index 35. Weathered and fresh surfaces are mottled pinkish buff and black. Map-unit 2c.

Petrographic Description. Fine to medium grained, massive, hypidiomorphic. Apatite forms euhedral crystals poikilitic in pyroxene and biotite. Pyroxene forms clear, colourless grains thickly mantled with amphibole and biotite. Biotite forms anhedral grains enclosing amphibole and pyroxene and forms distinct isolated grains. Amphibole is minor, rims pyroxene, and is often partially replaced by biotite. Plagioclase (An36-48) forms anhedral to euhedral grains which show spotty saussuritization. Moderate protoclastic texture is indicated by bent albite twin planes. Orthoclase forms anhedral, interstitial grains.

Map No. 586

Sample No. SHR 51-57

Perthite-bearing diorite.

Field Description. Medium grained, massive, equigranular. Colour index approximately 40. The outcrop is cut by quartz-bearing, coarse-grained pegmatite. Weathered surfaces are brown; fresh surfaces are mottled buff and black. The outcrop has a very weak schistosity. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is colourless augite which is mantled with biotite and amphibole. Apatite forms poikilitic inclusions in pyroxene, amphibole and biotite. Biotite forms large anhedral grains, some of which have bent (001) cleavage planes. Amphibole is green to brownish green anhedral hornblende. Cryptoperthite is interstitial to plagioclase. Plagioclase (An44) forms an interlocking mosaic of crystals, with well-developed protoclastic texture.

Map No. 587

Sample No. SHR 51-59 (not analysed)

Diorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 30. The outcrop is cut by aplitic dikes. Weathered and fresh surfaces are mottled pinkish buff and black. Map-unit 2c.

Petrographic Description. Medium grained, equigranular to inequigranular–porphyritic–seriate, allotriomorphic, with curved grain boundaries. Plagioclase (An41–50) grains form an interlocking mosaic. Larger grains display a moderate zonation with saussuritized cores; commonly the grains poikilitically enclose biotite. Pyroxene is anhedral augite, interlocking with feldspar. Pyroxene may enclose biotite and grains of myrmekitic intergrowth of pyroxene (?) and amphibole. Biotite forms irregular, rounded booklets within plagioclase, between plagioclase, and in association with pyroxene. Minor brown amphibole is possibly after pyroxene. Possibly some interstitial potassium feldspar is present.

Map No. 588

Sample No. SHR 51–63B

Pyroxene – biotite syenodiorite.

Field Description. Medium to coarse grained, massive. The outcrop is cut by fine-grained, aplitic dikes. Colour index approximately 30. Weathered surfaces are pink to red, fresh surfaces are mottled black and pinkish brown. Map–unit 2c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Plagioclase (An31–36) forms subhedral, interlocking grains with well-developed protoclastic texture. Biotite forms brown, subhedral grains, some with bent (001) cleavages. Pyroxene (augite) occurs as anhedral to euhedral grains mantled by biotite, very rarely by amphibole. Amphibole also forms spotty replacement on pyroxene. String perthite occurs as anhedral, interstitial grains. Apatite occurs as euhedral, poikilitic inclusions in biotite and pyroxene.

Map No. 589

Sample No. SHR 51–65A

Biotite – pyroxene syenodiorite.

Field Description. Medium to coarse grained, massive, inequigranular–seriate. The rock is weakly trachytoidal due to subparallel orientation of feldspar. One gneissic wall rock xenolith is present in the outcrop. Colour index approximately 10. Weathered and fresh surfaces are brown. The outcrop is cut by a coarse-grained hornblende–feldspar pegmatite. Map–unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Minor olivine forms rounded grains, locally altered to a reddish brown mineral. Pyroxene (augite) forms anhedral to subhedral grains. Biotite forms brown to reddish brown grains, some with bent (001) cleavages. Perthite forms anhedral grains, interstitial to plagioclase. Plagioclase (An38–42) forms anhedral to subhedral grains with protoclastic texture. Apatite forms euhedral grains poikilitic in pyroxene and biotite.

Map No. 590

Sample No. SHR 51–67A

Diorite.

Field Description. Medium to coarse grained, massive, equigranular. The outcrop is cut by coarse-grained hornblende–feldspar pegmatite. Weathered surfaces are buff and fresh surfaces mottled buff and greenish black. Map–unit 2c.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Apatite is poikilitic in pyroxene or its alteration

product. Pyroxene is a relict, colourless, augite in amphibole. Amphibole is a dark brown, interlocking mosaic of grains in association with brown, anhedral biotite. Amphibole is hornblende. Plagioclase forms an interlocking mosaic of anhedral grains displaying protoclastic texture. The protoclastic texture is defined by bent albite twin planes and fractures.

Map No. 591

Sample No. SHR 51-71B

Olivine diorite.

Field Description. Medium to almost coarse grained, equigranular, massive. The colour index is approximately 40, somewhat higher than normal. Weathered surfaces are grey and fresh surfaces are mottled grey and black. Map-unit 2c.

Petrographic Description. Coarse grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. Apatite is poikilitic in pyroxene and olivine. Olivine forms rounded anhedral grains in association with pyroxene and is mantled by or enclosed within biotite. Biotite forms large, anhedral grains with bent (001) cleavage. Pyroxene is augite and occurs interstitially to plagioclase which may contain small poikilitic grains of augite. Plagioclase (An43-51) forms an interlocking mosaic of grains with bent and fractured albite twin planes. Texture is protoclastic.

Map No. 592

Sample No. SHR 51-74A

Monzonite.

Field Description. Fine grained, massive, equigranular. The rock occurs as an irregular dike cutting medium- to coarse-grained diorite. Weathered and fresh surfaces are red. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Amphibole is anhedral, green to brownish-green hornblende. Biotite occurs as fine-grained aggregates. Plagioclase (An4) forms large grains which have undergone some potassium replacement and smaller grains which have been moderately saussuritized. Microcline is interstitial. Perthite is dominantly string perthite with some patches containing vestiges of albite twinning.

Map No. 593

Sample No. SHR 51-74B

Perthite-bearing diorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 30. Weathered and fresh surfaces are mottled pinkish buff and black. The outcrop is cut by hornblende-feldspar pegmatite and aplite dikes. Map-unit 2c.

Petrographic Description. Medium to coarse grained, massive, hypidiomorphic, protoclastic. Amphibole is pleochroic, brown to dark brown, subhedral hornblende. Biotite forms anhedral, brown grains, sometimes ragged in outline. Apatite forms euhedral crystals poikilitic in biotite and hornblende. Perthite forms anhedral, interstitial grains with stringy perthite texture. Plagioclase (An28-35) forms anhedral to euhedral crystals with patchy saussuritization.

Map No. 594

Sample No. SHR 51-76

Amphibole – biotite syenodiorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 35. Weathered and fresh surfaces are mottled buff and black. Map-unit 2c.

Petrographic Description. Coarse grained, massive, equigranular, hypidiomorphic. Apatite occurs as poikilitic inclusions in pyroxene and its alteration products. Brown to greenish brown amphibole in part replaces pyroxene. Pyroxene occurs as rare relicts in biotite and amphibole. Biotite forms large anhedral grains, some with bent (001) cleavage. Plagioclase (An35) forms anhedral, interlocking grains with bent twin lamellae and fractures. Texture is protoclastic. Perthite occurs as interstitial grains to plagioclase and cryptoperthite.

Map No. 595

Sample No. SHR 51-77

Monzonite.

Field Description. Fine grained, massive, equigranular. Colour index 15 to 20. The rock is a dike cutting medium- to coarse-grained diorite. Contacts of the dike are not clearly exposed. Weathered and fresh surfaces are brownish red. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Amphibole forms anhedral, brownish green to greenish brown grains, commonly in association with minor biotite. Plagioclase (An12) occurs as larger grains that have undergone patchy potassium feldspar replacement and as discrete grains that are intergranular to perthite. Perthite includes string perthite and minor patch perthite with vestiges of albite twinning.

Map No. 596

Sample No. SHR 51-81A

Diorite.

Field Description. Fine to medium grained, inequigranular-porphyritic-seriate. The rock cuts medium- to coarse-grained diorite in an irregular fashion with no clearly defined trend. Mafic minerals are slightly clotty and feldspar phenocrysts are up to 8 mm long in seriate distribution. The phenocrysts form approximately 5 percent of rock. Weathered and fresh surfaces are red. Map-unit 2c.

Petrographic Description. Coarse grained, massive, equigranular, hypidiomorphic. Pyroxene (augite) forms rare relicts within amphibole. Amphibole is dark brown, anhedral hornblende and is found in close association with biotite. Biotite forms anhedral, brown grains. Apatite is poikilitic in amphibole. Perthite is interstitial to plagioclase and in places encloses plagioclase in large amoeboid grains. Potassium feldspar occurs as patchy replacement of plagioclase. Plagioclase is protoclastic, with bent twin planes and fractures.

Map No. 597

Sample No. SHR 51-81B

Syenite aplite.

Field Description. Medium to coarse grained, equigranular, massive. Colour index 25-30 on weathered and fresh surfaces. The rock is mottled buff and black. Map-unit 2b.

Petrographic Description. Fine grained, inequigranular-seriate, massive, al-
lotriomorphic, with lobate grain boundaries. Amphibole is brown pleochroic
hornblende. Antiperthite is crudely stringy. Plagioclase (An8-11) forms discrete
grains interstitial to perthite.

Map No. 598

Sample No. SHR 51-87

Amphibole - biotite monzonite.

Field Description. Medium to coarse grained, massive, equigranular. Colour in-
dex approximately 35. The outcrop is cut by a hornblende-feldspar pegmatite.
Weathered and fresh surfaces are mottled pinkish buff and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomor-
phic, with curved to straight grain boundaries. Biotite forms anhedral, brown
grains with irregular outlines, bent (001) cleavage, and some kinking. Amphibole
(hornblende) is anhedral, pleochroic in green to yellowish-brown. Apatite forms
euhedral crystals in biotite and amphibole. Perthite forms interstitial anhedral
grains, some with random subrounded inclusions of plagioclase. Well developed
stringy texture. Plagioclase (An30-36) forms subhedral grains with well-
developed protoclastic texture.

Map No. 599

Sample No. SHR 51-90

Syenodiorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour in-
dex 35 to 40. Weathered surfaces are mottled buff and black. The outcrop is cut
by hornblende-feldspar pegmatite. Map-unit 2c.

Petrographic Description. Medium grained, equigranular, massive, allotriomor-
phic to hypidiomorphic. Pyroxene consists of anhedral grains of augite, often
relict and enclosed within amphibole. Amphibole is anhedral, green to brownish
green hornblende. Apatite is poikilitic in pyroxene, amphibole and biotite. Biotite
forms anhedral grains in association with amphibole and pyroxene. It may locally
mantle pyroxene and/or amphibole. Perthite is anhedral and interstitial to other
feldspars; likely it is cryptoperthite. Plagioclase (An42-44) is anhedral and dis-
plays a moderate to well-developed protoclastic texture.

Map No. 600

Sample No. SHR 51-94

Amphibole - biotite monzonite.

Field Description. Medium to coarse grained, inequigranular-seriate, massive.
Biotite is locally clotty and crystals up to 2 cm were noted on the outcrop. Colour
index approximately 35. Weathered surfaces are pinkish grey and black; fresh
surfaces are pink and black. Map-unit 2c.

Petrographic Description. Medium to coarse grained, massive, equigranular, al-
lotriomorphic, with straight to curved grain boundaries. Plagioclase (An34) forms
anhedral to subhedral grains with protoclastic features. Some saussuritization.
Perthite forms anhedral, interstitial grains with stringy perthite texture. Amphibole
(hornblende) forms anhedral brown to greenish-brown grains. Biotite forms
brown, irregular grains, with some kinking of (001) cleavage. Apatite forms
euhedral crystals poikilitic in amphibole and biotite.

Map No. 601

Sample No. SHR 51-107

Quartz monzonite.

Field Description. Fine grained, massive, equigranular, aplitic dike. The dike cuts trondhjemite gneissic wall rocks and is 70 cm wide. The gneiss is also cut by a pegmatite not likely related to the Shenango complex. Weathered and fresh surfaces are red. Map-unit 2a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries (aplitic). Quartz forms irregular, anhedral grains, in part interstitial to feldspars. Patchy antiperthite forms anhedral, irregular grains.

Map No. 602

Sample No. SHR 52-2B

Perthite-bearing, biotite - amphibole - pyroxene gabbro.

Field Description. Medium to coarse grained, inequigranular-seriate, massive. The outcrop is cut by coarse-grained hornblende-feldspar pegmatite and fine-grained aplitic dikes. Colour index 35 to 40. Weathered and fresh surfaces are mottled pink and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite is poikilitic in biotite, pyroxene and amphibole. Pyroxene (augite) forms anhedral, subhedral grains with spotty alteration of amphibole and biotite. Amphibole (hornblende) is pleochroic green to yellowish green, sometimes mantling pyroxene and sometimes forming discrete grains. Biotite forms anhedral, brown grains sometimes replacing pyroxene. Minor anhedral interstitial perthites are present. Plagioclase (An49-60) forms anhedral to subhedral interlocking grains with protoclastic texture.

Map No. 603

Sample No. SHR 52-4A

Pyroxene - biotite, diorite.

Field Description. Medium to coarse grained, massive, equigranular. Weathered surfaces are mottled grey-black; fresh surfaces are mottled pink and black. Colour index 35 to 40. Map-unit 2c.

Petrographic Description. Medium grained, equigranular, massive, allotriomorphic, with straight to curved grain boundaries. Pyroxene (augite) forms anhedral to subhedral grains with spotty replacement by green amphibole and biotite. Biotite forms brown, anhedral grains, some with bent (001) cleavage. Plagioclase (An32-48) forms anhedral to subhedral grains with well-developed protoclastic texture.

Map No. 604

Sample No. SHR 52-4B

Biotite - amphibole monzonite aplite.

Field Description. Fine grained, massive, equigranular, aplitic dike which cuts diorite. Weathered and fresh surfaces are red. Colour index between 5 and 10. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, trachytoidal, with curved to straight grain boundaries. Amphibole is anhedral, green to greenish brown hornblende. Biotite forms brown, anhedral to subhedral crystals. Microcline is interstitial to plagioclase, with some potassium alteration along grain boundaries. Plagioclase (An5-10) forms lath-like subparallel, subhedral grains.

Map No. 605

Sample No. SHR 52-11A

Biotite - amphibole monzonite.

Field Description. Fine to medium grained, equigranular, massive. Rock contains visible quartz. The sample is from a relatively flat-lying dike cutting medium- to coarse-grained diorite. Colour index 5. Weathered and fresh surfaces are red. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Myrmekite is interstitial and marginal to feldspar grains. Plagioclase (An32) forms anhedral to subhedral grains with well-developed protoclastic texture. Biotite forms anhedral to subhedral, brown grains. Amphibole (hornblende) is pleochroic, green to yellowish-green, anhedral hornblende. Perthite forms anhedral, interstitial grains with string perthite texture. Apatite is poikilitic in biotite and amphibole.

Map No. 606

Sample No. SHR 52-11B

Biotite - amphibole monzonite.

Field Description. Medium to coarse grained, massive, inequigranular-seriate. Weak suggestion of trachytoidal texture. Several amphibolite xenoliths. Weathered surface grey and black; fresh surface mottled brown and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, inequigranular, allotriomorphic, with curved to straight grain boundaries. Myrmekite is interstitial and marginal to feldspar grains. Plagioclase (An32) forms anhedral to subhedral grains with well-developed protoclastic texture. Biotite forms anhedral to subhedral brown grains. Amphibole (hornblende) is a pleochroic green to yellowish green and occurs in anhedral grains. Perthite occurs as interstitial grains with a string perthite texture. Apatite is poikilitic in biotite and amphibole.

Map No. 607

Sample No. SHR 52-16

Diorite.

Field Description. Medium to coarse grained, equigranular, massive. The outcrop is cut by aplitic dikes and coarse-grained pegmatite with miarolitic cavities up to 1 cm wide. Pegmatite is mostly feldspar. Colour index approximately 35. Weathered surfaces are rusty brown, fresh surfaces are mottled pinkish grey and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene (augite) forms irregular grains mantled with amphibole and biotite. Biotite is poikilitically enclosed in

some pyroxene grains. Amphibole (hornblende) forms anhedral, irregular grains in association with, and mantling, pyroxene. Biotite forms brown anhedral grains associated with pyroxene and amphibole. Apatite forms anhedral, poikilitic crystals in pyroxene, amphibole, and biotite. Plagioclase (An₃₂₋₃₆) forms anhedral to subhedral crystals with well-developed protoclastic textures.

Map No. 608

Sample No. SHR 52-18A

Porphyritic amphibole – biotite monzonite.

Field Description. Fine to medium grained, massive, inequigranular–porphyritic–seriate. Dike 40 cm wide. Plagioclase phenocrysts 4–5 mm long compose 5 to 10 percent of the rock. Biotite phenocrysts up to 3 mm in diameter form less than 5 percent of the rock. The groundmass is aphanitic. Weathered and fresh surfaces are reddish brown. Map–unit 2k.

Petrographic Description. Fine to coarse grained, massive, inequigranular–porphyritic–seriate, hypidiomorphic. Amphibole (hornblende), forms anhedral to subhedral crystals of brown to greenish–brown colour; some twinning is present. Biotite forms brown, anhedral crystals. Apatite occurs generally as tiny, poikilitic, euhedral crystals in feldspar. Plagioclase phenocrysts (An₄₅) are subhedral to almost euhedral, protoclastic and somewhat glomeroporphyritic. Plagioclase in the groundmass is anhedral and forms an interlocking mosaic with cryptoperthite (?). Spotty saussuritization. Scattered, brown, biotite phenocrysts.

Map No. 609

Sample No. SHR 52-18B

Monzonite aplite.

Field Description. Medium to coarse grained, equigranular, massive. Colour index approximately 40. Weathered and fresh surfaces are mottled grey and buff. Locally there are wall rock xenoliths of hornblende–plagioclase gneiss. The inclusions are angular to subangular. Map–unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Amphibole (hornblende) forms ragged, elongated, green hornblende crystals. Biotite forms fine–grained, brown, ragged, interstitial grains. Potassium feldspar is interstitial to and interlocking with plagioclase. Weak quadrille twinning of microcline is evident on several grains. Plagioclase (An₈₋₁₀) forms anhedral to subhedral grains; larger grains have a protoclastic texture.

Map No. 610

Sample No. SHR 52-18C

Amphibole syenite pegmatite.

Field Description. Coarse grained, equigranular, massive pegmatite. Colour index approximately 15. The pegmatite is irregular in width and trend. The pegmatite cuts medium– to coarse–grained diorite. Map–unit 2j.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Amphibole (hornblende) is anhedral to subhedral, pleochroic green to yellow green, and likely is sodic in composition. Patch perthite is antiperthitic with potassium feldspar replacement. Plagioclase

(An10–13) forms anhedral to subhedral grains with weak protoclastic texture. Perthite is stringy perthite, anhedral in outline.

Map No. 611

Sample No. SHR 52-18E

Biotite – pyroxene diorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 35. Weathered surfaces are brownish grey and black; fresh surfaces are grey and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene (augite) forms anhedral, irregular grains with some green amphibole replacement. Biotite forms brown, anhedral grains. Plagioclase (An48–52) forms anhedral to subhedral grains with well-developed protoclastic texture.

Map No. 612

Sample No. SHR 52-19

Perthite-bearing, amphibole – pyroxene – biotite diorite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 30. Weathered and fresh surfaces are mottled pink and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Pyroxene (augite) forms anhedral to euhedral crystals with patchy replacement by biotite and amphibole. Amphibole is green to brownish green; it sometimes rims pyroxene. Biotite forms anhedral, brown crystals with bent (001) cleavage. Perthite is anhedral and interstitial to plagioclase. Plagioclase (An38–42) forms anhedral to subhedral grains with well-developed protoclastic texture. Apatite forms euhedral crystals, poikilitic in pyroxene, amphibole, biotite, feldspar.

Map No. 613

Sample No. SHR 52-29

Biotite – amphibole monzonite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 20. Weathered and fresh surfaces are mottled buff and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Amphibole (hornblende) is pleochroic in green and brownish-green. Biotite forms brown anhedral grains with bent (001) cleavage. Plagioclase (An36) forms anhedral to subhedral grains with well-developed protoclastic texture. Perthite forms anhedral, irregular grains with well-developed, stringy texture; locally antiperthite has formed, with patchy replacement by potassium feldspar of plagioclase. Myrmekite forms anhedral, irregular grains interstitial to and marginal to feldspar grains.

Map No. 614

Sample No. SHR 52-35

Biotite – amphibole monzonite.

Field Description. Medium to coarse grained, massive, equigranular. Weathered and fresh surfaces are pinkish grey and black. Colour index approximately 20. Map-unit 2c.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Biotite forms brown grains with bent (001) cleavage. Amphibole (hornblende) is anhedral and pleochroic in green and greenish-brown. Perthite forms anhedral grains interstitial with and interlocking with plagioclase. Perthite has a well-developed stringy texture. Plagioclase (An30) is anhedral to subhedral, interlocking with perthite. Myrmekite is abundant along grain boundaries. Apatite is euhedral and poikilitic in biotite and amphibole.

Map No. 615

Sample No. SHR 52-37

Pyroxene - amphibole monzonite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 30. Weathered and fresh surfaces are mottled pinkish brown and black. Map-unit 2c.

Petrographic Description. Medium grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Pyroxene forms anhedral crystals mantled in amphibole and/or biotite. Amphibole (hornblende) is anhedral, green to greenish brown. Plagioclase (An35) forms anhedral, irregular grains with protoclastic textures. Some plagioclase grains are enclosed randomly in perthite. Perthite forms anhedral, irregular grains with stringy texture; myrmekite is common along grain boundaries. Some vermiform structures are present within the feldspar.

Map No. 616

Sample No. SHR 63-1A

Amphibolite.

Field Description. Fine grained, massive, equigranular, homogeneous. The rock is locally gneissic and has clots of quartz filling former amygdulites. The outcrop is cut by phases of the Shenango Township Complex. Weathered and fresh surfaces are black. Map-unit 1c.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, granoblastic, with curved grain boundaries. Quartz is interstitial. Amphibole is brown to yellow-brown hornblende. Plagioclase (An48-54) forms anhedral grains interlocking with amphibole.

Map No. 617

Sample No. SHR 63-2A

Quartz-bearing, amphibole - biotite monzonite.

Field Description. Medium grained, massive, equigranular. The rock cuts amphibolite in a ramifying pattern. Colour index approximately 25. Fresh and weathered surfaces are mottled red and black. Map-unit 2b.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Quartz is interstitial, anhedral. Amphibole is green to brownish green, anhedral hornblende. Biotite forms anhedral to subhedral grains in association with amphibole. Perthite forms anhedral grains interlocking with plagioclase. Perthite is of the string type. Plagioclase (An7-12) forms anhedral grains interlocking with perthite. Myrmekite is abundant along edges and interstitial to feldspar grains.

Map No. 618**Sample No. SHR 63-2B**

Monzonite.

Field Description. Fine grained, massive, equigranular. The unit occurs in lit-par-lit fashion with amphibolite. Both the sampled unit and amphibolite are cut by medium-grained monzonite. Fresh and weathered surfaces are reddish-brown. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Amphibole is brown to greenish brown, anhedral hornblende. Biotite forms anhedral crystals. Plagioclase (An13) forms anhedral crystals, commonly occurs as vestiges in cores of zoned perthite crystals and is commonly saussuritized. Perthite (?) is anhedral cryptoperthite, forming an interlocking mosaic with plagioclase.

Map No. 619**Sample No. SHR 63-4**

Amphibolite.

Field Description. Fine grained, equigranular, massive. The outcrop contains zones of amygdules and has a weak gneissic banding. The outcrop is extensively diked by monzonite and aplite. Weathered surfaces are grey; fresh surfaces are black. Map-unit 1c.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, granoblastic, with curved grain boundaries. Magnetite occurs as disseminated anhedral grains. Plagioclase (An54) forms anhedral, interlocking grains with amphiboles. Amphibole (hornblende) is brown to green and anhedral in form. Biotite forms anhedral, brown grains associated with amphibole.

Map No. 620**Sample No. SHR 63-8**

Quartz-bearing monzonite.

Field Description. Medium grained, massive, equigranular. Colour index 35 to 40. Weathered and fresh surfaces are mottled pink and black. Map-unit 2b.

Petrographic Description. Medium grained, equigranular, massive, allotriomorphic, with curved to lobate grain boundaries. Quartz is interstitial and unstressed. Pyroxene occurs in trace amounts in cores of amphibole grains. Amphibole is a brown to greenish-brown, anhedral hornblende containing poikilitic apatite. Biotite forms anhedral, irregular grains in association with amphibole. Perthite forms anhedral, irregular grains with stringy texture. Plagioclase forms an interlocking mosaic with perthite.

Map No. 621**Sample No. SHR 63-15**

Perthite-bearing, biotite - pyroxene diorite.

Field Description. Medium to coarse grained, equigranular. Colour index approximately 40. Weathered surfaces are red, fresh surfaces are reddish brown. Map-unit 2c.

Petrographic Description. Medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Plagioclase (An32-42)

forms anhedral to subhedral grains with well-developed protoclastic texture. Minor tremolite occurs as alteration of unknown mafic mineral. Biotite forms brown anhedral grains. Pyroxene (augite) forms anhedral to subhedral crystals with local spotty alteration to biotite or possibly amphibole. Perthite is of the string type, interstitial to the plagioclase, anhedral in outline. Apatite is euhedral, poikilitic in pyroxene and biotite.

Map No. 622

Sample No. SHR 63-18

Amphibole - pyroxene - biotite monzonite.

Field Description. Medium to coarse grained, massive, equigranular. There are several amphibolitic xenoliths in the outcrop. Colour index approximately 40. Weathered and fresh surfaces are mottled reddish brown and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Pyroxene (augite) forms anhedral grains undergoing replacement by biotite and amphibole. Biotite forms large, anhedral, reddish brown grains. Biotite has bent (001) cleavage and kink bands. Biotite poikilitically contains apatite and relict pyroxene. Myrmekite forms large amoeboid grains sometimes enclosing plagioclase. Apatite forms tiny, euhedral crystals poikilitic in biotite, amphibole, pyroxene. Perthite forms anhedral grains interstitial to and interlocking with plagioclase. Plagioclase (An₃₆) forms subhedral to anhedral grains, sometimes with weak protoclastic texture. Amphibole (hornblende) is pleochroic brown to greenish brown in colour, and occurs as distinct grains and as replacements of pyroxene.

Map No. 623

Sample No. SHR 63-20A

Monzonite.

Field Description. Fine grained, massive, equigranular rock which cuts amphibolite. Colour index approximately 15. Weathered and fresh surfaces are reddish brown to brownish red. Map-unit 2b.

Petrographic Description. Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Amphibole forms anhedral grains of brownish green to green hornblende. Plagioclase (An₁₀) forms anhedral crystals as part of an interlocking mosaic with stringy perthite.

Map No. 624

Sample No. SHR 63-23A

Amphibolite.

Field Description. Fine grained, equigranular, massive, weakly gneissic. Weathered and fresh surfaces are black. Locally, phases of the Shenango Township Complex cut the outcrop. Map-unit 1c.

Petrographic Description. Fine grained, equigranular, massive, allotriomorphic, granoblastic with curved grain boundaries. Amphibole is a brown to yellow brown hornblende. Plagioclase (An₄₄) and amphibole form an interlocking mosaic.

Map No. 625**Sample No. SHR 63-23B**

Monzonite.

Field Description. Fine grained, massive, equigranular, hornblende. The rock cuts amphibolites. Colour index approximately 25. Weathered and fresh surfaces are red. Map-unit 2b.

Petrographic Description. Fine grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. Stringy perthite forms an interlocking mosaic of grains with plagioclase (An₁₀). Patch perthite as a replacement of plagioclase by potassium feldspar is rare. Amphibole is brown to greenish brown hornblende and is closely associated with biotite. Minor myrmekite occurs interstitially.

Map No. 626**Sample No. SHW 64-12 (see sample 639 for second description)**

Quartz-bearing, amphibole - biotite monzonite.

Field Description. Fine to medium grained, massive, equigranular. Colour index approximately 40. Weathered and fresh surfaces are mottled pinkish-buff and black. Map-unit 2d.

Petrographic Description. Fine to medium grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. Amphibole (hornblende) is anhedral and pleochroic in green to yellow brown; locally it is interstitial to feldspar. Quartz is anhedral and interstitial. Biotite forms brown, anhedral grains in association with amphibole. Biotite may be poikilitically enclosed in the amphibole. Perthite is anhedral, stringy and partially engulfs plagioclase. Plagioclase (An₃₈) forms anhedral to subhedral crystals with spotty saussuritization.

Map No. 627**Sample No. SHW 1-8**

Syenodiorite.

Field Description. Fine grained, equigranular, massive. Weathered surfaces are speckled buff and black; fresh surfaces are speckled black and pale pink. The outcrop is cut by fine-grained, monzonite aplite. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Amphibole is hornblende of anhedral to subhedral form and is associated with brown biotite. Perthite is cryptoperthite with perthite structure (string-type) visible only at high magnification. Plagioclase is anhedral in outline and the grains have turbid, saussuritized cores.

Map No. 628**Sample No. SHW 20-5A**

Perthite-bearing, biotite - amphibole syenodiorite.

Field Description. Fine grained, massive, equigranular. Colour index approximately 40. Weathered surfaces are speckled buff and black; fresh surfaces are dark grey. Samples SHW 20-5A and SHW 20-5B are texturally gradational into each other. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite forms tiny, euhedral, poikilitic

crystals in feldspar, biotite and amphibole. Amphibole (hornblende) forms brown to yellowish-brown, euhedral grains. Biotite forms brown anhedral grains. Anhedral, interstitial grains of cryptoperthite and possibly microcline are present. Anhedral grains of plagioclase (An43-44) form an interlocking mosaic.

Map No. 629

Sample No. SHW 20-5B

Biotite - amphibole diorite.

Field Description. Fine to medium grained, massive, equigranular. Colour index approximately 40. Weathered and fresh surfaces are mottled pinkish-buff and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Amphibole (hornblende) is anhedral, pleochroic in green and yellow green, and interlocking with biotite. Biotite is anhedral to subhedral, brown in colour, and interlocking with amphibole. Plagioclase (An41-45) forms an anhedral, interlocking mosaic of grains. Apatite is euhedral, poikilitic in amphibole, biotite and plagioclase.

Map No. 630

Sample No. SHW 37-4A

Pyroxene - biotite - amphibole monzonite.

Field Description. Fine grained, massive, equigranular. The outcrop is veined with quartz monzonite; possible miarolitic cavities in the quartz monzonite are up to 1/2 cm in diameter. Weathered and fresh surfaces are mottled pink and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Plagioclase (An36-42) forms anhedral to subhedral grains, some with saussuritized cores, some with possible zoning. Biotite forms anhedral, brown grains. Amphibole (hornblende) forms green to yellowish-green grains, generally replacing pyroxene. Pyroxene (augite) forms ragged grains mantled with amphibole and undergoing patchy replacement by amphibole. Perthite is a cryptoperthite (?), interstitial to plagioclase and rarely engulfing a plagioclase grain. Apatite is euhedral and poikilitic in pyroxene, amphibole and biotite.

Map No. 631

Sample No. SHW 37-10A

Perthite-bearing, biotite - amphibole diorite.

Field Description. Medium to coarse grained, massive, equigranular, diorite. Colour index approximately 45. Weathered and fresh surfaces are mottled reddish-brown and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic, with protoclastic texture. Perthite forms anhedral, irregular grains interstitial to plagioclase. Plagioclase (An30?) is anhedral to subhedral with bent albite twin planes. Amphibole forms anhedral to subhedral, brown to greenish-brown grains. Biotite is brown, anhedral to subhedral grains with bent (001) cleavage. Apatite forms euhedral, poikilitic inclusions in biotite and amphibole.

Map No. 632

Sample No. SHW 37-12

Amphibole - pyroxene - biotite syenodiorite.

Field Description. Medium to coarse grained, equigranular, very weakly foliated. Colour index approximately 40. Weathered and fresh surfaces are pinkish-buff and black. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Plagioclase (An37-41) forms anhedral, interlocking grains with well-developed protoclastic texture. Perthite forms anhedral, irregular grains interstitial to plagioclase. Amphibole (hornblende) is brown to greenish-brown in colour, anhedral in outline. Pyroxene (augite) forms anhedral to subhedral grains in association with biotite and amphibole. Apatite is euhedral and poikilitic in amphibole. Biotite forms brown, anhedral grains in association with pyroxene and amphibole.

Map No. 633

Sample No. SHW 50-9

Amphibole - biotite syenodiorite.

Field Description. Fine grained, massive, equigranular. Weathered and fresh surfaces are mottled or speckled red and black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Plagioclase (An36-46) forms an interlocking mosaic of anhedral crystals. Amphibole is brown to greenish-brown, anhedral to euhedral, elongated hornblende; rarely it poikilitically encloses biotite. Biotite forms brown, anhedral grains. Perthite forms anhedral grains interlocking with plagioclase. Perthite has a stringy or braided texture. Apatite occurs as small, euhedral crystals poikilitic in biotite, amphibole and feldspar.

Map No. 635

Sample No. SHW 64-2

Quartz-bearing, amphibole - biotite monzonite.

Field Description. Medium grained, massive, inequigranular-seriate. Mafic mineral is acicular. Colour index is approximately 35. Weathered surfaces are pink, fresh surfaces are mottled red and black. Map-unit 2b.

Petrographic Description. Fine to medium grained, equigranular, massive, albitic, with curved to straight grain boundaries. Amphibole forms pleochroic green to yellow brown, anhedral grains of hornblende, interstitial to feldspar. Quartz is anhedral and interstitial. Biotite forms anhedral grains in association with amphibole. Some biotite is enclosed in amphibole. Perthite is anhedral, interstitial to and partly engulfs plagioclase. Perthite is stringy. Plagioclase (An36) is anhedral to subhedral and displays spotty saussuritization.

Map No. 636

Sample No. SHW 64-4

Syenodiorite.

Field Description. Fine to medium grained, massive, equigranular. Colour index approximately 40. Weathered and fresh surfaces are mottled pink and black. The

rock may be a fine-grained phase of the diorite centred at Shiners Lake. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite and brown to yellow-brown hornblende form anhedral grains with poikilitic apatite. Biotite is engulfed in amphibole in one or two cases. Perthite is interstitial to plagioclase; generally a cryptoperthite or weakly-developed string perthite. Plagioclase (An₃₁₋₃₈) forms anhedral grains often with saussuritized, albite-twinned cores and fresh untwinned rims.

Map No. 637

Sample No. SHW 64-8A

Monzonite.

Field Description. Fine grained, massive, inequigranular-porphyritic-seriate. Phenocrysts are up to 2 mm in size, composing 5 percent of the rock. The rock is possibly a dike phase, weathered and fresh surface reddish-brown. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Plagioclase (An₄₋₁₂) forms an interlocking mosaic of grains with potassium feldspar. Spotty saussuritization. Potassium feldspar is orthoclase. Biotite and green to brownish-green amphibole form anhedral grains. The sample may represent a chilled facies of monzonite.

Map No. 638

Sample No. SHW 64-8B

Quartz-bearing monzonite.

Field Description. Fine to medium grained, equigranular. Colour index approximately 15. Weathered and fresh surfaces are red. Map-unit 2b.

Petrographic Description. Medium grained, equigranular to inequigranular-seriate, allotriomorphic, with curved to lobate grain boundaries. Amphibole is brown to greenish-brown, anhedral in form and commonly associated with brown biotite. Perthite forms large, irregular grains with stringy texture. Marginal to the perthite grains, distinct grains of plagioclase are present together with minor interstitial quartz. Quartz is clear and unstressed.

Map No. 639 (see sample 626 for analysis)

Sample No. SHW 64-12

Biotite - hornblende monzonite.

Field Description. Fine grained, massive, homogeneous, equigranular. Weathered surfaces are buff; fresh surfaces are grey. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Amphibole forms anhedral to subhedral, green to greenish-brown grains. Minor biotite forms brown grains, anhedral in outline, and associated with amphibole. Apatite is poikilitic in amphibole and biotite. Stringy perthite forms anhedral grains, interlocking with plagioclase. Plagioclase (An₃₂₋₃₄) forms anhedral to subhedral grains with saussuritized cores and rare weak zoning.

Map No. 640

Sample No. X1-1B

Gabbro.

Field Description. Fine grained, massive, equigranular. The rock is cut by quartz-feldspar veinlets. Weathered surfaces are buff to grey; fresh surfaces are dark grey. Probably a dike rock.

Petrographic Description. Fine grained, massive, equigranular to inequigranular-porphyritic-seriate, hypidiomorphic. Pyroxene forms anhedral to euhedral grains; larger grains tend to be euhedral and strongly zoned. Biotite forms anhedral, irregular grains, perhaps replacing some pyroxene. Biotite also occurs as fine-grained, polycrystalline aggregates possibly after olivine and in association with tremolite (?). Plagioclase (An52-60) forms an interlocking mosaic of anhedral grains. Apatite is euhedral and occurs as poikilitic inclusions in pyroxene, biotite, and feldspar.

Map No. 641

Sample No. X1-4

Syenodiorite.

Field Description. Medium to coarse grained, massive, equigranular. The outcrop has a weak foliation and is cut by pegmatite dikes. Weathered and fresh surfaces are reddish-brown. Map-unit 2d.

Petrographic Description. Medium grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Apatite is poikilitic in pyroxene which is colourless, anhedral augite, commonly mantled with biotite. Biotite forms large, irregular books sometimes enclosing pyroxene. Biotite has bent (001) cleavage planes. Perthite is stringy or cryptoperthite. Plagioclase (An34-36) is anhedral and together with perthite forms an interlocking mosaic.

Map No. 642

Sample No. X2-7

Monzonite.

Field Description. Fine grained to medium grained, massive, inequigranular-seriate. Colour index 15 to 20 percent. Fresh and weathered surfaces are red. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Amphibole is dark green, anhedral, commonly associated with biotite. Amphibole is likely a sodic variety. Plagioclase (An9-10) forms anhedral grains undergoing potassium feldspar emplacement. Microcline is interstitial. Stringy perthite forms anhedral, irregular grains; minor patch perthite is present. Feldspar grains form an interlocking mosaic.

Map No. 643

Sample No. X4-1

Pyroxene monzonite.

Field Description. Fine grained, massive, equigranular. Weathered surfaces are brown; fresh surfaces are dark grey. Map-unit 2b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries; aplitic. Magnetite occurs as rounded, anhedral grains. Pyroxene (augite) forms rounded, bead-like, anhedral grains. Stringy perthite forms an interlocking mosaic with plagioclase.

Map No. 644

Sample No. X4-3B

Monzonite.

Field Description. Medium grained, massive, equigranular. Amphiboles (?) are slightly acicular. This phase occurs as xenolithic blocks in a coarser-grained

phase. Colour index approximately 40. Weathered and fresh surfaces are brownish-red. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Amphibole forms anhedral, green to brownish-green grains of hornblende. Biotite forms anhedral grains in association with amphibole. Feldspars form an interlocking mosaic of grains with carlsbad twinning and vestiges of albite twinning. Feldspars are likely cryptoperthite. The feldspars show spotty, moderate to intense saussuritization. The sample likely represents a chilled phase of the monzonite.

Map No. 645

Sample No. X4-3C

Biotite - pyroxene diorite.

Field Description. Medium to coarse grained, equigranular, massive. Colour index approximately 10. Weathered and fresh surfaces are brown. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene (augite) forms anhedral to subhedral grains with spotty alteration, and is associated with biotite and amphibole. Biotite forms anhedral brown grains with bent (001) cleavage. Apatite forms euhedral grains poikilitic in biotite and amphibole. Plagioclase (An₃₅₋₃₇) forms anhedral to subhedral grains, interlocking with well-developed protoclastic texture. Minor green amphibole rims and replaces pyroxene.

Map No. 646

Sample No. X4-6

Monzonite.

Field Description. Medium grained, massive, equigranular. Colour index 25. Weathered surfaces are brownish red; fresh surfaces are mottled red and black. The weathered surface is pitted from weathering out of mafic minerals. Map-unit 2b.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Anhedral feldspar grains consist of patch antiperthite and plagioclase (An₈₋₁₂). Amphibole is dark greenish brown, possibly a sodium-iron variety, and forms euhedral to anhedral crystals. Biotite forms anhedral grains in close association with amphibole.

Map No. 647

Sample No. X4-8

Biotite - pyroxene diorite.

Field Description. Medium to coarse grained, equigranular, massive. Colour index approximately 10. Weathered and fresh surfaces are brown. Map-unit 2c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Olivine forms minor, rounded grains with rusty brown alteration. Apatite forms euhedral, poikilitic grains in biotite and pyroxene. Biotite forms brown to greenish-brown, anhedral grains. One crystal of pyroxene is enveloped by bent biotite grains. Pyroxene (augite) forms anhedral to euhedral grains. Plagioclase (An₄₁₋₄₆) forms anhedral to subhedral grains with protoclastic texture.

Map No. 648

Sample No. X4-10

Amphibole – pyroxene syenite.

Field Description. Fine to medium grained, equigranular, massive. Colour index 10. Weathered and fresh surfaces are brown. Scattered, isolated grains of biotite are visible in the outcrop. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Olivine forms rounded grains with traces of fresh olivine. Olivine is altered to dark brown iddingsite. Pyroxene (augite) forms anhedral to euhedral grains of very pale green tint, in part altering to green hornblende. Amphibole (hornblende) is green to pale green, and forms a mantle to pyroxene. Large grains of perthite are generally patchy, rarely stringy; vestiges of albite twinning (An28) and some weak protoclastic textures are evident.

Map No. 649

Sample No. AG 20-10

Diorite.

Field Description. Medium to coarse grained, massive, equigranular. Weathered surfaces are buff, fresh surfaces are pinkish buff. Map-unit 2c.

Petrographic Description. Coarse grained, massive, equigranular, hypidiomorphic. Pyroxene forms anhedral, colourless grains mantled with biotite and amphibole. Amphibole (hornblende) forms brown to yellow brown rims on pyroxene. Biotite occurs as rims on pyroxene and as large, anhedral aggregate of crystals. Plagioclase (An35-43) forms an interlocking mosaic of anhedral grains which show weak, spotty saussuritization. Well developed protoclastic texture is indicated by bent and fractured albite twin planes.

Map No. 650

Sample No. AH 19-2A

Diorite (possible hybrid).

Field Description. Fine to coarse grained, inequigranular-porphyritic-seriate. Very well-developed trachytoidal texture. The rock occurs between amphibolite and monzonite and may be a hybrid. Not assigned a map-code.

Petrographic Description. Fine to coarse grained, massive, inequigranular, porphyritic-seriate, allotriomorphic, with curved grain boundaries. Pyroxene (augite) forms colourless, anhedral grains. Amphibole (hornblende) and biotite form brown, anhedral grains in close association with each other. Minor accessory magnetite is present. Plagioclase (An38-48) forms phenocrysts (about 20% of rock) and anhedral, groundmass grains in an interlocking mosaic. Phenocrysts contain occasional poikilitic inclusion of biotite, or amphibole. Groundmass plagioclase contains poikilitic inclusions of pyroxene and amphibole.

Map No. 651

Sample No. AH 19-2D

Syenodiorite.

Field Description. Fine grained, equigranular, massive. Weathered surfaces are mottled pinkish-buff and black. Fresh surfaces are mottled pink and black. Weak schistosity is present. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Perthite is of string type and is interstitial; it forms amoeboid-like grains with occasional colourless clear orthoclase (?) peripheries. Anhedra grains of plagioclase (An28-35) form an interlocking mosaic with perthite. Amphibole is greenish-brown anhedra hornblende. Minor biotite is associated with amphibole.

Map No. 652

Sample No. AH 19-3A

Amphibolite.

Field Description. Fine grained, equigranular. The rock displays weak banding in outcrop. Weathered surfaces are grey black, fresh surfaces are black. Map-unit 1c.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Quartz forms an interlocking mosaic of anhedra grains with poikilitic inclusions of amphibole. Amphibole consists of anhedra, brown to yellowish-brown hornblende with some bead-like grains of poikilitic plagioclase. Minor biotite is associated with amphibole. Plagioclase (An54) forms anhedra grains with abundant poikilitic inclusions of amphibole.

Map No. 653

Sample No. AH 19-5A

Amphibolite.

Field Description. Fine grained, massive, equigranular, weakly schistose. Weathered surfaces are grey black, fresh surfaces are black. Map-unit 1c.

Petrographic Description. Fine grained, foliated, equigranular, allotriomorphic, granoblastic elongate, with curved grain boundaries. Quartz forms anhedra, elongated clots. Amphibole is yellowish brown hornblende; larger grains contain bead-like inclusions of plagioclase. Plagioclase (An45-51) forms anhedra grains, extensively saussuritized. Subrounded clots of quartz may be recrystallized former amygdale fillings.

Map No. 654

Sample No. AH 19-6

Monzonite.

Field Description. Fine to medium grained, equigranular. Amphiboles are acicular. Weathered and fresh surfaces are pinkish-red. Map-unit 2d.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Perthite is a patch antiperthite and grains have lobate grain boundaries. Minor plagioclase (An30-35) occurs as distinct grains between larger perthite grains. Amphibole is a dark greenish-brown hornblende of a sodium-iron variety. Amphibole forms subhedra grains. Minor biotite is associated with amphibole.

Map No. 655

Sample No. AH 20-17

Syenodiorite.

Field Description. Fine grained, equigranular, massive. Weathered surfaces are mottled pinkish-buff and black; fresh surfaces are pinkish-black. Map-unit 2d.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Plagioclase (An30–36) forms anhedral grains with local areas extensively saussuritized. Pyroxene forms clear, colourless relicts mantled with amphibole and biotite. Pyroxene is extensively replaced. Amphibole is greenish-brown hornblende, anhedral to subhedral in form. Biotite forms anhedral grains replacing pyroxene and occurs in association with amphibole.

Map No. 656

Sample No. SH1 100–100.5' (drill core)

Quartz-bearing, biotite monzonite. Map-unit 2b.

Fine grained, massive, equigranular, hypidiomorphic. Quartz is anhedral and interstitial to feldspar. Perthite forms anhedral to euhedral interlocking grains with plagioclase; it has weak stringy texture. Plagioclase (An8–12) forms anhedral to euhedral grains interlocking with perthite. Sphene forms euhedral, wedge-shaped, brown crystals. Myrmekite is common, intergranular to the feldspars. Biotite forms anhedral brown grains.

Map No. 657

Sample No. SH1 416.3–416.8' (drill core)

Quartz-bearing, amphibole – biotite monzonite. Map-unit 2b.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Perthite is anhedral and interlocking with plagioclase. Very fine-grained cryptoperthite is present. Plagioclase (An10–13) forms anhedral to subhedral crystals, showing local saussuritization. Quartz is anhedral and interstitial. Amphibole is anhedral, pleochroic green to yellow brown. Amphibole is hornblende. Biotite is anhedral, brown in colour.

Map No. 658

Sample No. SH1 479.1–479.5' (drill core)

Quartz-bearing, biotite monzonite. Map-unit 2b.

Fine grained, massive, equigranular, hypidiomorphic. Biotite forms anhedral, ragged grains occurring in aggregates, imparting a pseudoporphyritic texture to the rock. Perthite forms anhedral grains interlocking with plagioclase. Plagioclase (An2–9) forms anhedral to euhedral grains moderately to extensively saussuritized. Quartz is anhedral and interstitial. Minor myrmekite occurs along grain boundaries.

Map No. 659

Sample No. SH2 105.1–105.6' (drill core)

Hornblende monzonite. Map-unit 2b.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Apatite is euhedral and poikilitic in amphibole. Amphibole (hornblende) is green to brownish green, subhedral in outline. Plagioclase (An10–11) forms anhedral to subhedral grains interlocking with perthite. Perthite is a stringy type and some may be cryptoperthite.

Map No. 660

Sample No. SH2 162.4–162.8' (drill core)

Biotite – amphibole monzonite. Map-unit 2b.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Amphibole (hornblende) is anhedral, pleochroic green to greenish-

brown. Stringy perthite forms anhedral grains. Myrmekite forms interstitial intergrowths. Plagioclase (An₄₂) forms anhedral interlocking grains. Biotite forms anhedral, brown grains associated with amphibole.

Map No. 661

Sample No. SH2 248.3–248.6' (drill core)

Quartz-bearing, amphibole monzonite. Map-unit 2b.

Fine grained, equigranular, allotriomorphic, with curved to straight grain boundaries. Quartz is anhedral, interstitial. Plagioclase (An_{7–10}) grains are anhedral and interlocking with anhedral stringy perthite. Amphibole (hornblende) is anhedral, pleochroic in green and yellow green. Biotite forms anhedral, brown grains. Myrmekite occurs along grain boundaries and as interstitial grains.

Map No. 662

Sample No. SH2 296.25–296.4' (drill core)

Hornblende – monzonite aplite. Map-unit 2b.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Perthite forms anhedral grains interlocking with plagioclase; it has weak perthitic texture. Amphibole is green to brownish-green hornblende, anhedral to subhedral in outline. Minor biotite is anhedral and brown in colour. Plagioclase forms an interlocking mosaic of anhedral grains. Apatite is poikilitic in feldspar, biotite, and amphibole.

Map No. 663

Sample No. SH2 300.5–301.0' (drill core)

Quartz-bearing, biotite – amphibole monzonite. Map-unit 2b.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Quartz is anhedral and interstitial. Amphibole (hornblende) is anhedral and pleochroic in green and yellow green. Biotite is anhedral to subhedral, pleochroic in brown. Perthite is anhedral, interlocking with plagioclase; it shows weak stringy texture at high magnification. Plagioclase (An₇) forms anhedral interlocking grains. Minor myrmekite occurs along grain boundaries.

Map No. 664

Sample No. SH2 365.5–366.0' (drill core)

Quartz-bearing, biotite monzonite. Map-unit 2b.

Fine to medium grained, massive, equigranular, hypidiomorphic. Biotite forms brown, anhedral grains. Quartz forms clear, interstitial grains. Plagioclase (An₁₁) forms weakly zoned, subhedral grains interlocking with perthite. Perthite forms anhedral to subhedral crystals with vestiges of albite twinning. Some grains have well-developed quadrille twinning of microcline. Patchy saussuritization. String perthite is common, patch perthite uncommon. Myrmekite along grain boundaries may comprise 10 percent of total feldspar. Intense stain for potassium was observed along grain boundaries and cleavages.

TABLE A-2. MAJOR ELEMENT ANALYSES OF WHOLE-ROCK SAMPLES FROM THE SHENANGO TOWNSHIP ALKALIC ROCK COMPLEX

Map No.	UNIT 1C					UNIT 2A	
	616	619	624	652	653	551	557
SiO ₂	52.0	50.3	51.3	53.2	52.9	67.2	71.5
Al ₂ O ₃	14.2	14.1	14.1	14.6	15.0	16.0	14.8
Fe ₂ O ₃	3.96	4.82	4.96	3.71	4.84	1.56	0.80
FeO	8.05	8.53	8.05	6.65	8.24	1.69	1.21
MgO	5.77	5.52	6.04	5.89	3.18	0.26	0.06
CaO	9.40	9.81	9.81	9.95	10.40	0.98	0.73
Na ₂ O	2.47	2.30	2.35	2.04	1.24	4.89	4.32
K ₂ O	0.66	0.59	0.46	0.58	0.31	5.34	4.63
TiO ₂	1.28	1.32	1.30	0.99	1.21	0.19	0.13
P ₂ O ₅	0.16	0.15	0.14	0.08	0.05	0.07	0.05
S	<0.01	-	-	0.01	0.01	<0.01	0.01
MnO	0.21	0.21	0.21	0.20	0.22	0.04	0.03
CO ₂	0.20	0.18	0.22	0.14	0.16	0.32	0.36
H ₂ O +	0.48	0.62	0.32	1.48	0.61	0.15	0.28
H ₂ O -	0.21	0.35	0.30	0.03	0.05	0.27	0.28

Map No.	UNIT 2A			UNIT 2B			
	564	570	601	637	638	635	642
SiO ₂	70.1	66.5	64.8	59.2	60.9	54.6	58.8
Al ₂ O ₃	15.0	16.9	16.5	18.1	18.3	17.1	17.7
Fe ₂ O ₃	1.07	0.54	2.86	1.33	2.05	2.05	2.46
FeO	1.05	1.53	1.37	4.19	2.82	6.44	4.02
MgO	0.02	0.49	0.01	0.75	0.32	2.50	0.51
CaO	1.04	1.89	1.02	2.42	1.67	5.20	2.41
Na ₂ O	4.48	5.05	5.99	5.27	5.80	4.48	6.03
K ₂ O	5.39	5.49	4.72	5.93	5.80	3.63	5.39
TiO ₂	0.06	0.16	0.22	0.31	0.29	0.94	0.43
P ₂ O ₅	0.03	0.07	0.09	0.20	0.06	0.52	0.20
S	0.02	0.04	0.03	0.01	0.01	0.02	<2.01
MnO	0.06	0.04	<0.01	0.12	0.09	0.16	0.18
CO ₂	0.36	0.36	0.05	0.15	0.15	0.40	0.15
H ₂ O +	0.03	0.06	0.10	0.21	0.12	0.82	0.32
H ₂ O -	0.51	0.15	0.34	0.34	0.31	0.36	0.28

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
616	SHR 63-1A
619	SHR 63-4
624	SHR 63-23A
652	AH 19-3A
653	AH 19-5A
551	SHR 29-2A
557	SHR 29-12C

Map No.	Sample No.
564	SHR 38-4
570	SHR 49-3D
601	SHR 51-107
637	SHW 64-8A
638	SHW 64-8B
635	SHW 64-2
642	X2-7

TABLE A-2 continued.

UNIT 2B							
Map No.	646	556	581	592	595	597	604
SiO ₂	57.3	57.9	56.9	60.6	59.6	63.2	60.1
Al ₂ O ₃	17.1	17.6	18.3	18.2	17.8	17.2	18.5
Fe ₂ O ₃	2.12	2.31	2.48	1.43	1.48	1.25	2.44
FeO	5.23	4.19	5.31	2.90	3.70	3.14	3.14
MgO	0.42	0.60	0.71	0.25	0.37	0.32	0.02
CaO	3.16	3.35	3.18	1.60	2.23	1.67	1.67
Na ₂ O	4.67	5.50	5.39	5.06	5.07	6.18	6.31
K ₂ O	6.16	4.77	5.89	7.17	6.79	5.37	5.66
TiO ₂	0.63	0.77	0.31	0.23	0.27	0.18	0.11
P ₂ O ₅	0.16	0.13	0.17	0.10	0.12	0.08	0.06
S	0.01	0.01	<0.01	<0.01	-	<0.01	<0.01
MnO	0.18	0.13	0.22	0.11	0.12	0.12	0.18
CO ₂	0.32	0.52	0.26	0.30	0.46	0.32	0.30
H ₂ O +	0.11	0.43	0.43	0.22	0.43	0.43	0.66
H ₂ O -	0.52	0.34	0.31	0.35	0.47	0.44	0.25

UNIT 2B							
Map No.	609	618	617	620	623	625	656
SiO ₂	61.8	55.2	55.8	54.1	60.0	59.2	56.9
Al ₂ O ₃	17.7	18.0	17.5	16.3	17.4	17.2	18.7
Fe ₂ O ₃	1.72	3.71	1.74	2.41	2.86	2.26	4.90
FeO	3.70	5.39	6.28	7.64	4.42	4.75	3.14
MgO	0.00	1.48	1.72	1.85	0.25	0.55	0.72
CaO	1.72	4.43	3.97	4.64	2.28	2.59	2.99
Na ₂ O	6.12	4.72	5.12	4.67	5.75	5.35	4.95
K ₂ O	5.88	4.05	4.39	3.79	5.54	5.64	4.40
TiO ₂	0.15	1.04	0.81	1.57	0.45	0.52	0.86
P ₂ O ₅	0.06	0.47	0.44	0.45	0.10	0.18	0.23
S	-	-	-	-	-	-	-
MnO	0.16	0.18	0.16	0.22	0.20	0.17	0.14
CO ₂	0.16	0.20	0.20	0.22	0.22	0.24	0.28
H ₂ O +	-0.05	0.34	0.38	0.46	0.23	0.11	0.45
H ₂ O -	0.48	0.40	0.35	0.38	0.28	0.37	0.50

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
646	X4-6	609	SHR 52-18B
556	SHR 29-12B	618	SHR 63-2B
581	SHR 51-54	617	SHR 63-2A
592	SHR 51-74A	620	SHR 63-8
595	SHR 51-77	623	SHR 63-20A
597	SHR 51-81B	625	SHR 63-23B
604	SHR 52-4B	656	SH1 100-100.5

TABLE A-2 continued.

UNIT 2B							
Map No.	657	658	659	660	661	662	663
SiO ₂	59.8	58.8	58.3	56.9	61.8	55.8	58.2
Al ₂ O ₃	17.0	17.7	16.1	19.9	16.5	18.8	17.1
Fe ₂ O ₃	3.27	4.36	1.80	1.69	1.70	2.17	1.75
FeO	3.46	3.22	5.88	4.19	3.70	5.31	5.31
MgO	0.44	0.43	0.74	0.68	0.43	0.75	0.73
CaO	2.45	2.51	3.13	2.41	2.15	2.97	2.92
Na ₂ O	4.50	4.22	4.41	3.98	3.94	4.79	4.65
K ₂ O	6.48	5.85	6.24	6.83	6.91	5.57	5.85
TiO ₂	0.64	0.71	0.91	0.69	0.54	0.93	0.86
P ₂ O ₅	0.14	0.16	0.24	0.18	0.14	0.24	0.22
S	<0.01	<0.01	<0.01	0.04	<0.01	0.02	0.02
MnO	0.16	0.16	0.22	0.16	0.16	0.19	0.17
CO ₂	0.28	0.26	0.26	0.26	0.28	0.24	0.24
H ₂ O +	0.26	0.35	0.20	0.37	0.08	0.24	0.15
H ₂ O -	0.50	0.43	0.45	0.62	0.45	0.52	0.39

UNIT 2B				UNIT 2C			
Map No.	664	643	567	583	631	632	645
SiO ₂	57.9	56.1	61.2	62.2	50.3	51.4	48.2
Al ₂ O ₃	18.9	16.3	17.0	17.6	16.9	19.6	16.9
Fe ₂ O ₃	4.33	3.70	2.33	1.78	2.36	1.49	2.60
FeO	2.98	6.12	3.62	2.17	8.86	6.12	9.58
MgO	0.37	0.79	0.05	0.25	3.09	2.54	3.49
CaO	2.71	3.63	1.66	1.41	6.31	6.46	7.91
Na ₂ O	5.64	4.35	6.42	6.69	4.08	4.90	3.99
K ₂ O	4.95	5.33	5.25	5.59	3.02	2.99	2.13
TiO ₂	0.62	1.26	0.25	0.13	1.72	1.35	1.74
P ₂ O ₅	0.11	0.43	0.06	0.05	0.70	0.61	0.97
S	0.02	0.02	0.02	0.01	0.04	<0.01	0.03
MnO	0.13	0.23	0.16	0.10	0.22	0.15	0.22
CO ₂	0.30	0.28	0.20	0.36	0.20	0.10	0.24
H ₂ O +	0.14	0.27	0.16	0.49	0.73	0.40	0.39
H ₂ O -	0.39	0.38	0.25	0.38	0.38	0.36	0.55

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
657	SH1 416.3-416.8
658	SH1 479.1-479.5
659	SH2 105.1-105.6
660	SH2 162.4-162.8
661	SH2 248.3-248.6
662	SH2 296.25-296.4
663	SH2 300.5-301.0

Map No.	Sample No.
664	SH2 365.5-366.0
643	X4-1
567	SHR 49-3A
583	SHR 51-55
631	SHW 37-10A
632	SHW 37-12
645	X4-3C

TABLE A-2 continued.

UNIT 2C							
Map No.	647	562	563	561	565	573	572
SiO ₂	45.5	54.0	56.3	55.8	52.4	51.0	51.2
Al ₂ O ₃	16.4	20.7	19.6	17.8	19.0	20.0	20.7
Fe ₂ O ₃	14.4	1.11	1.03	1.19	1.60	1.48	1.21
FeO	1.14	4.51	4.03	5.80	5.55	5.96	5.47
MgO	4.15	1.84	1.51	2.18	2.92	2.91	2.60
CaO	8.31	6.38	4.95	5.17	5.82	6.92	7.42
Na ₂ O	3.44	5.28	4.84	4.23	4.39	4.43	4.68
K ₂ O	1.63	2.68	4.35	3.94	3.59	3.20	2.46
TiO ₂	2.52	1.00	0.74	1.13	1.09	1.17	1.21
P ₂ O ₅	0.98	0.38	0.31	0.49	0.50	0.68	0.57
S	0.05	0.02	0.01	<0.01	0.01	<0.01	<0.01
MnO	0.25	0.10	0.09	0.14	0.14	0.14	0.12
CO ₂	0.24	0.26	0.28	0.26	0.22	0.24	0.30
H ₂ O +	0.22	0.17	0.12	0.19	0.99	0.50	0.45
H ₂ O -	0.51	0.69	0.50	0.47	0.50	0.24	0.35

UNIT 2C							
Map No.	576	578	577	579	580	582	585
SiO ₂	48.7	50.4	49.9	49.2	50.8	48.7	48.2
Al ₂ O ₃	17.7	20.0	20.0	21.3	21.2	21.6	19.6
Fe ₂ O ₃	2.47	1.65	1.59	2.25	2.52	2.61	1.42
FeO	8.13	6.36	6.36	5.39	4.59	5.55	7.16
MgO	3.87	2.53	2.91	2.62	2.15	2.83	3.34
CaO	5.63	7.13	7.12	7.92	5.97	7.58	8.09
Na ₂ O	3.90	4.62	4.75	4.66	4.61	4.32	3.85
K ₂ O	4.34	2.68	2.76	2.38	3.32	3.02	3.01
TiO ₂	1.55	1.40	1.23	1.15	1.35	1.39	1.75
P ₂ O ₅	0.71	0.60	0.62	0.60	0.34	0.51	0.84
S	0.1	0.01	0.01	0.01	0.01	<0.01	<0.01
MnO	0.20	0.13	0.14	0.14	0.12	0.11	0.14
CO ₂	0.22	0.26	0.34	0.18	0.32	0.22	0.18
H ₂ O +	0.89	0.54	0.71	0.50	0.56	0.37	0.96
H ₂ O -	0.49	0.43	0.39	0.34	0.47	0.41	0.37

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
647	X4-8	576	SHR 51-37
562	SHR 36-9	578	SHR 51-43
563	SHR 38-3	577	SHR 51-40
561	SHR 36-8	579	SHR 51-50A
565	SHR 38-5B	580	SHR 51-52
573	SHR 51-10	582	SHR 51-54B
572	SHR 51-2B	585	SHR 51-55D

TABLE A-2 continued.

Map No.	UNIT 2C						
	586	588	589	590	591	593	594
SiO ₂	47.3	52.5	52.3	51.3	44.6	51.6	52.2
Al ₂ O ₃	18.3	8.0	19.1	21.4	20.2	20.1	20.5
Fe ₂ O ₃	2.41	1.26	2.06	1.23	1.88	1.76	0.34
FeO	8.45	6.60	5.64	5.39	8.21	5.96	6.28
MgO	3.75	2.82	2.53	1.88	3.88	2.16	1.82
CaO	6.87	6.38	6.41	7.39	9.88	5.97	5.93
Na ₂ O	3.88	4.82	4.33	4.90	3.23	4.99	4.90
K ₂ O	3.78	3.56	3.50	2.40	1.70	3.34	3.66
TiO ₂	2.05	1.31	1.20	1.03	1.34	1.00	0.95
P ₂ O ₅	1.07	0.49	0.54	0.57	1.60	0.53	0.53
S	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	-
MnO	0.18	0.15	0.14	0.12	0.16	0.15	0.12
CO ₂	0.20	0.30	0.24	0.26	0.36	0.34	0.36
H ₂ O +	0.73	0.50	0.36	0.49	0.67	0.61	0.29
H ₂ O -	0.49	0.35	0.33	0.34	0.31	0.40	0.40

Map No.	UNIT 2C						
	596	598	599	600	602	603	605
SiO ₂	54.0	55.8	50.8	51.4	48.5	48.7	70.2
Al ₂ O ₃	20.5	19.6	19.0	19.8	19.2	20.4	15.0
Fe ₂ O ₃	1.20	1.10	1.92	1.54	1.79	1.77	0.33
FeO	4.27	4.27	6.60	1.36	7.57	6.44	1.93
MgO	1.48	0.76	2.65	1.89	3.22	3.09	0.00
CaO	5.60	4.33	6.42	5.62	7.54	8.46	1.03
Na ₂ O	5.26	4.53	4.12	4.46	3.88	4.12	5.16
K ₂ O	4.05	5.56	4.10	4.14	3.32	2.35	4.80
TiO ₂	0.64	0.73	1.28	0.96	1.45	1.43	0.07
P ₂ O ₅	0.34	0.32	0.65	0.46	0.97	0.78	0.03
S	-	-	0.02	<0.01	<0.01	0.02	-
MnO	0.12	0.12	0.15	0.18	0.16	0.13	0.06
CO ₂	0.22	0.34	0.30	0.40	0.24	0.26	0.40
H ₂ O +	0.28	0.35	0.67	0.99	0.50	0.60	0.08
H ₂ O -	0.41	0.39	0.41	0.40	0.36	0.26	0.23

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
586	SHR 51-57
588	SHR 51-63B
589	SHR 51-65A
590	SHR 51-67A
591	SHR 51-71B
593	SHR 51-74B
594	SHR 51-76

Map No.	Sample No.
596	SHR 51-81A
598	SHR 51-87
599	SHR 51-90
600	SHR 51-94
602	SHR 52-2B
603	SHR 52-4A
605	SHR 52-11A

TABLE A-2 continued.

UNIT 2C							
Map No.	606	611	607	612	613	614	615
SiO ₂	55.2	49.2	49.3	51.3	58.3	56.8	59.2
Al ₂ O ₃	19.5	21.7	20.3	20.4	18.2	19.1	18.5
Fe ₂ O ₃	1.22	1.34	1.79	16.1	1.17	18.6	1.65
FeO	4.43	5.31	6.44	5.15	3.78	4.03	3.38
MgO	1.81	2.58	2.62	2.58	0.87	1.15	0.57
CaO	5.17	9.91	8.14	8.10	2.97	4.36	2.69
Na ₂ O	5.00	4.11	4.39	4.69	4.18	5.16	4.23
K ₂ O	4.00	1.71	2.42	2.39	7.03	4.67	7.20
TiO ₂	0.86	0.94	1.41	1.06	0.77	0.84	0.59
P ₂ O ₅	0.34	0.78	0.79	0.72	0.25	0.34	0.24
S		0.03	0.02	<0.01	<0.01	<0.01	
MnO	0.11	0.12	0.13	0.12	0.10	0.12	0.12
CO ₂	0.30	0.26	0.20	0.24	0.22	0.22	0.18
H ₂ O +	0.40	0.51	0.34	0.36	0.09	0.09	0.58
H ₂ O -	0.26	0.25	0.35	0.27	0.27	0.27	0.44

UNIT 2C				UNIT 2D			
Map No.	621	622	649	627	628	629	630
SiO ₂	50.7	52.6	52.6	51.9	50.4	50.4	50.3
Al ₂ O ₃	17.0	16.9	21.5	17.5	17.9	18.0	17.9
Fe ₂ O ₃	2.16	2.52	0.98	1.61	1.70	2.06	1.74
FeO	8.77	7.81	5.35	7.73	7.65	7.33	7.33
MgO	2.88	2.04	1.90	2.95	2.92	3.36	4.08
CaO	6.86	5.15	7.30	6.12	6.44	6.32	7.80
Na ₂ O	4.36	5.35	4.18	4.31	4.45	4.12	4.01
K ₂ O	2.34	3.18	2.51	3.65	3.49	3.59	2.96
TiO ₂	1.72	1.55	0.90	1.09	1.12	1.05	0.97
P ₂ O ₅	0.69	0.48	0.41	0.60	0.72	0.68	0.55
S	0.02	<0.01	0.01	<0.01	0.01	0.02	0.03
MnO	0.22	0.21	0.12	0.18	0.17	0.18	0.17
CO ₂	0.22	0.26	0.16	0.10	0.40	0.50	0.20
H ₂ O +	0.29	0.67	0.70	0.62	0.54	0.25	0.35
H ₂ O	0.41	0.40	0.04	0.27	0.30	0.34	0.42

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
606	SHR 52-11B	621	SHR 63-15
611	SHR 52-18E	622	SHR 63-18
607	SHR 52-16	649	AG 20-10
612	SHR 52-19	627	SHW 1-8
613	SHR 52-29	628	SHW 20-5A
614	SHR 52-35	629	SHW 20-5B
615	SHR 52-37	630	SHW 37-4A

TABLE A-2 continued.

	UNIT 2D						
Map No.	571	633	636	626	641	644	648
SiO ₂	51.4	53.0	51.8	52.8	53.4	53.2	56.6
Al ₂ O ₃	18.6	17.7	17.4	17.8	18.5	19.2	16.8
Fe ₂ O ₃	1.43	1.88	1.29	1.95	2.52	2.42	2.78
FeO	6.28	6.92	8.29	6.84	6.36	5.96	4.75
MgO	4.06	2.50	2.78	2.94	1.86	1.92	0.34
CaO	8.81	5.12	5.87	5.88	5.16	5.45	2.68
Na ₂ O	3.64	4.71	4.74	4.45	4.47	5.76	5.03
K ₂ O	2.68	3.96	3.63	3.65	3.52	2.66	5.80
TiO ₂	0.77	1.12	1.21	0.95	1.37	0.32	0.52
P ₂ O ₅	0.44	0.62	0.73	0.54	0.44	0.36	0.13
S	0.01	0.01	<0.01	0.04	0.01	0.01	0.02
MnO	0.15	0.16	0.19	0.17	0.19	0.27	0.25
CO ₂	0.15	0.15	0.15	0.15	0.10	0.26	0.36
H ₂ O +	0.40	0.47	0.58	0.71	0.35	0.35	0.09
H ₂ O -	0.44	0.41	0.36	0.40	0.34	0.46	0.46

	UNIT 2D						
Map No.	548	549	552	558	553	555	554
SiO ₂	50.8	51.0	53.0	52.3	53.9	53.4	51.4
Al ₂ O ₃	17.9	17.6	17.3	18.3	17.5	17.9	17.8
Fe ₂ O ₃	1.79	2.05	1.89	1.92	1.98	2.00	1.04
FeO	7.00	6.76	6.44	6.28	6.36	6.36	6.87
MgO	4.13	3.82	3.67	2.61	2.63	2.66	4.40
CaO	7.09	7.13	6.45	5.89	5.33	5.48	7.90
Na ₂ O	3.79	4.18	4.08	4.36	4.75	4.52	4.19
K ₂ O	3.32	3.10	3.75	3.92	3.91	3.84	2.73
TiO ₂	0.97	0.92	0.77	0.96	0.83	0.96	0.74
P ₂ O ₅	0.53	0.56	0.46	0.59	0.54	0.54	0.47
S	0.03	0.04	0.01	0.04	0.02	0.01	0.03
MnO	0.17	0.18	0.16	0.16	0.17	0.16	0.16
CO ₂	0.34	0.42	0.26	0.42	0.40	0.42	0.36
H ₂ O +	0.56	1.39	0.82	0.53	0.52	0.58	0.89
H ₂ O -	0.32	0.32	0.35	0.28	0.33	0.33	0.28

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
571	SHW 50-10
633	SHW 50-9
636	SHW 64-4
626	SHW 64-12
641	X1-4
644	X4-3B
648	X4-10

Map No.	Sample No.
548	SHR 1-1
549	SHR 1-7
552	SHR 29-2B
558	SHR 29-12F
553	SHR 29-3
555	SHR 29-12A
554	SHR 29-9

TABLE A-2 continued.

Map No.	UNIT 2D						
	559	584	569	654	651	655	566
SiO ₂	50.1	48.2	50.4	58.6	60.4	49.6	48.8
Al ₂ O ₃	18.2	18.8	17.5	16.4	18.7	19.0	19.6
Fe ₂ O ₃	2.05	2.02	1.42	2.37	3.00	3.37	1.63
FeO	7.08	7.81	7.16	5.78	6.07	7.32	6.52
MgO	3.68	3.24	4.42	1.32	1.93	3.01	4.40
CaO	7.64	7.36	8.35	3.86	2.35	7.88	9.38
Na ₂ O	3.83	3.64	3.94	5.04	4.56	3.79	3.53
K ₂ O	2.88	3.52	2.97	5.06	4.28	3.06	2.66
TiO ₂	1.00	1.46	0.92	0.62	0.40	0.98	0.86
P ₂ O ₅	0.52	0.77	0.48	0.32	0.11	0.16	0.47
S	0.01	0.07	0.09	0.01	0.01	0.07	0.01
MnO	0.16	0.20	0.16	0.22	0.29	0.17	0.15
CO ₂	0.26	0.24	0.30	0.21	0.22	0.26	0.24
H ₂ O +	0.65	1.09	0.55	0.53	0.52	0.95	0.86
H ₂ O -	0.29	0.35	0.23	0.12	0.04	0.15	0.27

Map No.	UNIT 2H	UNIT 2J		UNIT 2K		MISC	
	560	550	574	610	608	640	650
SiO ₂	47.1	62.9	56.9	61.7	51.5	49.3	51.6
Al ₂ O ₃	12.2	19.0	18.20	18.5	18.5	13.6	19.5
Fe ₂ O ₃	16.4	0.83	2.30	1.68	2.00	2.63	4.74
FeO	1.23	1.45	5.07	2.66	7.65	5.31	4.48
MgO	4.61	0.00	0.74	0.00	2.04	8.78	1.95
CaO	9.34	1.00	2.86	1.51	5.41	10.60	8.90
Na ₂ O	2.53	6.67	4.86	6.60	4.36	2.83	3.91
K ₂ O	1.21	6.21	6.67	5.27	4.39	2.78	2.23
TiO ₂	3.02	0.05	0.42	0.06	0.98	0.74	0.93
P ₂ O ₅	0.20	0.03	0.20	0.03	0.62	0.39	0.73
S	0.59	0.03	<0.01	0.05	0.02	0.01	0.02
MnO	0.25	0.07	0.16	0.14	0.20	0.17	0.17
CO ₂	1.12	0.26	0.32	0.26	0.26	0.25	0.25
H ₂ O +	0.39	0.13	0.39	0.20	0.47	0.56	0.06
H ₂ O -	0.26	0.46	0.39	0.28	0.45	0.39	0.06

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
559	SHR 29-13	560	SHR 29-15
584	SHR 51-55B	550	SHR 51-18B
569	SHR 49-3C	574	SHR 51-18A
654	AH 19-6	610	SHR 52-18C
651	AH 19-2D	608	SHR 52-18A
655	AH 20-17	640	X1-1B
566	SHR 49-1	650	AH 19-2A

TABLE A-3. TRACE ELEMENT ANALYSES OF WHOLE-ROCK SAMPLES FROM THE SHENANGO TOWNSHIP ALKALIC ROCK COMPLEX

Map No.	UNIT 1C					UNIT 2A	
	616	619	624	652	653	551	557
Ag	<1		<1	<1	<1	<1	<1
As				4	<1		
Ba	240	200	150	200	150	400	390
Co	46	50	51	30	60	5	<5
Cr	130	104	108	100	80	<5	<5
Cu	85	32	56	40	150	9	30
Li	10	7	6	<20	<20	8	10
Ni	80	80	78	80	100	<5	<5
Pb	<10	11	16	<10	10	40	46
Sb				<4	<4		
Zn	116	128	128	110	120	48	70
Be	<1		<1	<3		9	9
Mo	<1		<1	<10	<10	<1	<1
Sc	35		35	20	30	<5	<5
Sr	200		200	200	200	200	150
V	500		<10	250	300	15	<10
Y	35		60	<20	30	45	25
Ga	10		15	15	15	15	15
Nb	<30		<30	<10	<10	200	150
Rb	20	20	<10	<10	<10	180	210
Zr	150		150	200	250	450	200
Sn	<3		<3	<10	<10	<3	<3
Eu	<100		<100			<100	<100
Yb	3		2			3	2
Hg					<20		
Ce	220	230	200	<500	<500	200	160
La	<100		<100	10	10	<100	<100
Nd	<100		<100	<300	<300	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No. Sample No.
 616 SHR 63-1A
 619 SHR 63-4
 624 SHR 63-23A
 652 AH 19-3A

Map No. Sample No.
 653 AH 19-5A
 551 SHR 29-2A
 557 SHR 29-12C

TABLE A-3 continued.

Map No.	UNIT 2A			UNIT 2B			
	564	570	601	637	638	635	642
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	110	1300	120	1300	660	1200	1500
Co	<5	9	5	8	<5	21	7
Cr	<5	<5	<5	<5	17	<5	<5
Cu	6	35	5	14	6	36	9
Li	4	6	<3	10	4	15	7
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	20	32	27	20	40	32	26
Zn	28	45	48	108	73	114	118
Be	15	10	10	5	5	6	8
Mo	<1	<1	<1	<1	<1	<1	<1
Sc	<5	<5	<5	5	<5	15	5
Sr	150	350	35	250	200	500	250
V	<10	25	<10	15	<10	150	<10
Y	30	50	70	35	45	45	45
Ga	15	15	20	15	15	15	15
Nb	150	100	200	150	100	200	250
Rb	290	170	200	100	110	110	170
Zr	200	200	600	300	700	800	700
Sn	<3	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	3	6	2	2	3	3
Ce	90	150	290	500	670	450	340
La	<100	<100	<100	150	450	200	150
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No. Sample No.
 564 SHR 38-4
 570 SHR 49-3D
 601 SHR 51-107
 637 SHW 64-8A

Map No. Sample No.
 638 SHW 64-8B
 635 SHW 64-2
 642 X2-7

TABLE A-3 continued.

Map No.	UNIT 2B						
	646	556	581	592	595	597	604
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	600	3400	600	700	600	390	110
Co	5	5	10	9	9	7	5
Cr	8	<5	5	<5	<5	9	<5
Cu	16	14	8	16	13	10	18
Li	4	9	4	4	8	3	10
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	46	31	22	25	22	15	44
Zn	98	124	134	74	97	68	140
Be	3	9	5	8	5	15	9
Mo	<1	<1	<1	<1	<1	<1	<1
Sc	15	25	<5	<5	<5	<5	<5
Sr	200	350	300	250	200	150	150
V	<10	<10	<10	<10	<10	<10	<10
Y	30	60	45	40	35	35	30
Ga	9	15	9	9	9	15	15
Nb	250	250	300	250	150	250	25
Rb	130	120	190	220	210	280	200
Zr	250	800	900	1500	800	700	800
Sn	<3	<3	4	<3	<3	<3	4
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	1	4	2	2	2	2	2
Ce	380	660	350	320	250	250	310
La	100	250	250	<100	<100	150	250
Nd	<100	<100	200	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
646	X4-6
556	SHR 29-12B
581	SHR 51-54
592	SHR 51-74A

Map No.	Sample No.
595	SHR 51-77
597	SHR 51-81B
604	SHR 52-4B

TABLE A-3 continued.

Map No.	UNIT 2B						
	609	618	617	620	623	625	656
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	90	2200	1500	2500	220	1300	2600
Co	<5	13	16	10	<5	5	11
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	12	68	24	20	6	15	24
Li	5	9	14	14	6	10	15
Ni	<5	60	<5	<5	<5	<5	<5
Pb	56	23	16	25	23	21	24
Zn	142	128	116	150	11	100	109
Be	10	2200	6	5	5	6	6
Mo	<1	<1	<1	<1	<1	7	<1
Sc	<5	9	7	20	10	7	7
Sr	80	600	500	600	80	250	400
V	<10	20	50	<10	<10	<10	<10
Y	45	40	40	50	40	40	45
Ga	15	9	15	15	10	10	15
Nb	200	60	200	150	200	150	150
Rb	320	90	150	100	110	160	140
Zr	1000	200	250	300	250	600	700
Sn	4	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	2	2	2	2	2	2
Ce	340	390	240	520	270	350	440
La	250	<100	250	250	<100	<100	<100
Nd	150	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
609	SHR 52-18B
618	SHR 63-2B
617	SHR 63-2A
620	SHR 63-8

Map No.	Sample No.
623	SHR 63-20A
625	SHR 63-23B
656	SH1 100-100.5

TABLE A-3 continued.

Map No.	UNIT 2B						
	657	658	659	660	661	662	663
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	1900	1900	1700	2800	2000	3600	3600
Co	<5	5	7	6	5	7	6
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	18	40	79	56	43	41	35
Li	8	10	7	8	7	12	12
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	26	31	20	76	35	31	30
Zn	103	85	131	150	103	120	114
Be	6	5	5	5	6	5	5
Mo	<1	<1	<1	<1	2	<1	3
Sc	10	10	15	10	10	15	15
Sr	250	250	200	300	250	500	500
V	<10	<10	<10	<10	<10	<10	<10
Y	40	45	60	45	50	45	45
Ga	15	15	15	15	15	15	15
Nb	200	150	250	150	100	250	200
Rb	170	160	170	160	210	140	160
Zr	250	300	700	250	250	600	600
Sn	4	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	2	5	2	4	2	2
Ce	260	480	440	320	270	410	510
La	150	250	200	<100	<100	150	200
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
657	SH1 416.3-416.8
658	SH1 479.1-479.5
659	SH2 105.1-105.6
660	SH2 162.4-162.8

Map No.	Sample No.
661	SH2 248.3-248.6
662	SH2 296.25-296.4
663	SH2 300.5-301.0

TABLE A-3 continued.

Map No.	UNIT 2B				UNIT 2C		
	664	643	567	583	631	632	645
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	1400	2200	50	250	1200	4100	2700
Co	<5	7	<5	<5	24	19	27
Cr	<5	<5	<5	<5	39	10	12
Cu	15	16	12	16	31	39	35
Li	16	<3	5	<3	14	17	9
Ni	<5	<5	<5	<5	20	8	<5
Pb	44	21	32	20	26	34	13
Zn	85	144	173	79	128	94	132
Be	4	<1	10	10	7	4	3
Mo	<1	1	<1	<1	<1	<1	1
Sc	6	20	7	<5	10	10	20
Sr	200	150	15	150	600	1000	1000
V	<10	<10	<10	<10	150	60	150
Y	40	45	50	35	25	20	35
Ga	15	15	15	15	15	15	9
Nb	200	70	400	100	100	100	70
Rb	140	60	240	230	120	90	50
Zr	700	250	600	800	250	100	150
Sn	<3	<3	3	<3	3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	2	4	2	1	<1	2
Ce	260	520	340	350	480	550	640
La	200	150	300	300	150	150	<100
Nd	150	<100	200	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
664	SH2 365.5-366.0
643	X4-1
567	SHR 49-3A
583	SHR 51-55

Map No.	Sample No.
631	SHW 37-10A
632	SHW 37-12
645	X4-3C

TABLE A-3 continued.

Map No.	UNIT 2C						
	647	562	563	561	565	573	572
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	2100	1400	2400	2000	1400	1800	2000
Co	29	14	12	20	19	20	20
Cr	6	17	37	27	47	28	23
Cu	30	24	21	23	20	35	24
Li	7	16	20	17	18	18	15
Ni	<5	10	12	16	19	20	16
Pb	<10	25	20	31	10	12	12
Zn	198	80	72	90	84	84	78
Be	<1	5	4	5	5	4	4
Mo	2	<1	<1	<1	<1	<1	<1
Sc	25	10	18	10	10	10	10
Sr	900	1000	900	700	800	1000	1000
V	150	70	50	80	70	90	80
Y	25	20	15	25	20	20	15
Ga	10	15	9	9	9	10	9
Nb	70	80	100	<30	100	90	80
Rb	40	80	110	120	120	110	80
Zr	100	250	150	150	400	150	150
Sn	<3	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	<1	<1	1	1	<1	<1
Ce	690	270	170	270	400	410	320
La	<100	<100	<100	<100	<100	100	<100
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
647	X4-8
562	SHR 36-9
563	SHR 38-3
561	SHR 36-8

Map No.	Sample No.
565	SHR 38-5B
573	SHR 51-10
572	SHR 51-2B

TABLE A-3 continued.

Map No.	UNIT 2C						
	576	578	577	579	580	582	585
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	2000	2600	2000	2000	3400	3100	4300
Co	30	17	21	20	18	22	23
Cr	29	10	21	44	11	11	6
Cu	33	32	18	30	28	34	46
Li	27	14	20	20	20	14	16
Ni	22	<5	13	17	7	7	7
Pb	12	<10	12	11	72	61	20
Zn	136	90	94	78	92	78	89
Be	5	4	4	<1	3	<1	<1
Mo	<1	<1	<1	<1	<1	<1	<1
Sc	10	15	10	15	8	10	15
Sr	600	1000	1000	1000	1000	1500	1000
V	100	50	80	90	50	100	80
Y	25	20	20	15	15	20	20
Ga	9	9	15	10	10	9	10
Nb	100	100	80	90	90	90	70
Rb	180	90	100	70	130	100	100
Zr	250	200	100	150	150	200	100
Sn	<3	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	1	<1	<1	<1	<1	<100	<1
Ce	430	370	360	380	480	420	600
La	<100	<100	<100	<100	<100	<100	<100
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
576	SHR 51-37
578	SHR 51-43
577	SHR 51-40
579	SHR 51-50A

Map No.	Sample No.
580	SHR 51-52
582	SHR 51-54B
585	SHR 51-55D

TABLE A-3 continued.

Map No.	UNIT 2C						
	586	588	589	590	591	593	594
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	4500	2200	3300	3300	1700	1600	1800
Co	30	20	22	17	38	17	18
Cr	7	78	32	11	23	7	7
Cu	70	30	28	44	52	22	22
Li	15	18	9	14	10	18	13
Ni	<5	18	11	5	35	<5	<5
Pb	10	11	11	10	<10	12	<10
Zn	115	101	85	76	93	112	105
Be	4	4	<1	4	<1	4	<1
Mo	<1	<1	<1	<1	<1	<1	<1
Sc	15	15	10	9	6	9	6
Sr	1000	800	1000	1500	1500	900	1000
V	70	90	80	50	150	70	80
Y	30	25	15	20	25	30	20
Ga	9	10	10	15	9	15	9
Nb	100	80	70	100	35	250	90
Rb	140	140	70	90	50	130	130
Zr	200	80	60	250	100	300	150
Sn	<3	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	1	1	<1	1	1	1	<1
Ce	690	420	340	450	390	400	330
La	<100	<100	<100	<100	<100	150	<100
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
586	SHR 51-57
588	SHR 51-63B
589	SHR 51-65A
590	SHR 51-67A

Map No.	Sample No.
591	SHR 51-71B
593	SHR 51-74B
594	SHR 51-76

TABLE A-3 continued.

Map No.	UNIT 2C						
	596	598	599	600	602	603	605
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	1900	3700	2000	1400	1900	2100	100
Co	14	8	22	18	24	22	<5
Cr	16	6	9	7	13	15	<5
Cu	14	20	35	14	36	30	9
Li	20	8	8	15	12	16	7
Ni	8	<5	<5	<5	9	6	<5
Pb	15	15	11	<10	12	<10	22
Zn	83	66	106	116	110	100	36
Be	5	<1	4	7	<1	4	15
Mo	<1	<1	<1	<1	<1	1	<1
Sc	<5	7	9	8	15	15	<5
Sr	1000	1000	1000	900	900	1500	<3
V	45	<10	90	70	100	100	<10
Y	20	15	25	25	25	25	30
Ga	10	8	15	15	9	10	15
Nb	200	50	150	150	80	80	250
Rb	130	110	140	180	90	70	340
Zr	250	100	200	200	100	200	300
Sn	<3	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	<1	<1	2	1	1	1	1
Ce	220	290	440	370	460	510	120
La	<100	<100	<100	<100	<100	<100	<100
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
596	SHR 51-81A
598	SHR 51-87
599	SHR 51-90
600	SHR 51-94

Map No.	Sample No.
602	SHR 52-2B
603	SHR 52-4A
605	SHR 52-11A

TABLE A-3 continued.

Map No.	UNIT 2C						
	606	611	607	612	613	614	615
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	2000	1400	2400	1900	2100	3300	940
Co	14	20	21	16	7	10	7
Cr	30	17	10	28	<5	<5	<5
Cu	21	44	33	23	14	15	14
Li	14	14	13	7	4	7	5
Ni	11	11	7	17	<5	<5	<5
Pb	11	10	25	12	14	15	13
Zn	70	78	88	74	62	82	62
Be	3	4	<1	4	<1	5	<1
Mo	<1	1	<1	<1	<1	<1	<1
Sc	9	10	10	15	10	9	8
Sr	900	1500	1500	1500	500	900	300
V	50	100	80	60	<10	20	<10
Y	20	20	20	20	15	25	<10
Ga	10	9	10	10	8	9	7
Nb	90	<30	70	80	100	70	35
Rb	80	50	70	60	110	100	120
Zr	150	90	100	100	200	200	90
Sn	<3	<3	<3	<3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	<1	<1	<1	1	<1	<1	<1
Ce	380	270	410	380	290	300	190
La	<100	<100	<100	<100	<100	<100	<100
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
606	SHR 52-11B
611	SHR 52-18E
607	SHR 52-16
612	SHR 52-19

Map No.	Sample No.
613	SHR 52-29
614	SHR 52-35
615	SHR 52-37

TABLE A-3 continued.

Map No.	UNIT 2C			UNIT 2D			
	621	622	649	627	628	629	630
Ag	<1	<1	<1	<1	<1	<1	<1
As			<1				
Ba	4900	2000	4000	1600	1600	1700	1500
Co	20	14	10	28	26	29	30
Cr	22	26	15	6	5	<5	19
Cu	27	30	20	42	15	28	45
Li	6	21	20	12	18	18	16
Ni	5	<5	50	<5	<5	6	13
Pb	12	18	10	49	31	28	36
Sb			<4				
Zn	134	154	70	112	118	118	104
Be	<1	5	<3	5	5	5	5
Mo	<1	<1	10	<1	<1	<1	<1
Sc	20	15	<20	15	15	10	20
Sr	900	700	1000	600	600	600	700
V	80	20	50	200	150	150	150
Y	30	35	<20	30	30	25	20
Ga	9	15	15	15	9	9	10
Nb	60	100	100	150	70	150	100
Rb	40	90	40	120	120	110	100
Zr	250	500	150	250	250	700	200
Sn	<3	<3	<10	<3	<3	<3	<3
Eu	<100	<100		<100	<100	<100	<100
Yb	1	2		2	2	2	2
Ce	670	500	500	390	370	370	290
La	<100	<100	40	100	100	100	<100
Nd	<100	<100	300	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No. Sample No.
 621 SHR 63-15
 622 SHR 63-18
 649 AG 20-10
 627 SHW 1-8

Map No. Sample No.
 628 SHW 20-5A
 629 SHW 20-5B
 630 SHW 37-4A

TABLE A-3 continued.

Map No.	UNIT 2D						
	571	633	636	626	641	644	648
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	1200	1700	1500	1400	7700	1000	400
Co	28	22	25	26	13	15	5
Cr	34	<5	<5	6	8	25	5
Cu	64	40	18	40	18	35	19
Li	25	16	20	12	7	6	4
Ni	23	<5	<5	5	<5	20	<5
Pb	30	24	24	37	14	54	92
Zn	86	104	126	110	108	196	84
Be	4	6	6	6	3	7	<1
Mo	7	<1	<1	<1	<1	<1	3
Sc	20	15	15	15	15	8	15
Sr	700	500	600	500	1000	1000	150
V	150	150	150	150	35	35	<10
Y	20	30	30	30	20	40	10
Ga	15	15	10	15	10	15	7
Nb	80	150	100	150	70	350	70
Rb	90	130	150	180	60	60	110
Zr	100	300	250	350	200	600	100
Sn	<3	<3	<3	<3	<3	4	8
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	1	2	2	2	1	2	<1
Ce	330	450	380	450	780	600	160
La	150	100	100	150	<100	250	<100
Nd	<100	<100	<100	<100	<100	250	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No. Sample No.
 571 SHW 50-10
 633 SHW 50-9
 636 SHW 64-4
 626 SHW 64-12

Map No. Sample No.
 641 X1-4
 644 X4-3B
 648 X4-10

TABLE A-3 continued.

Map No.	UNIT 2D						
	548	549	552	558	553	555	554
Ag	<1	<1	<1	<1	<1	<1	<1
Ba	1500	1300	1100	1600	1500	1800	1300
Co	29	28	27	24	23	28	30
Cr	8	23	9	<5	5	7	5
Cu	49	40	54	44	41	44	58
Li	15	16	19	13	11	23	18
Ni	16	19	14	5	6	8	25
Pb	24	31	24	20	29	18	26
Zn	96	118	108	124	94	130	90
Be	5	5	6	6	7	6	6
Mo	<1	20	<1	<1	<1	<1	<1
Sc	20	15	20	15	15	15	25
Sr	700	600	600	600	500	600	700
V	150	150	150	150	100	150	150
Y	30	30	40	35	35	35	30
Ga	15	15	15	15	9	15	15
Nb	150	150	150	150	100	150	150
Rb	110	110	140	140	130	180	120
Zr	250	200	300	300	250	300	250
Sn	<3	<3	<3	3	<3	<3	<3
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	2	2	2	2	2	2
Ce	420	830	360	430	500	360	270
La	150	100	<100	<100	<100	150	<100
Nd	<100	<100	<100	<100	<100	<100	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.
548	SHR 1-1
549	SHR 1-7
552	SHR 29-2B
558	SHR 29-12F

Map No.	Sample No.
553	SHR 29-3
555	SHR 29-12A
554	SHR 29-9

TABLE A-3 continued.

Map No.	UNIT 2D						
	559	584	569	654	651	655	566
Ag	<1	<1	<1	<1	<1	<1	<1
As				<1	<1		
Ba	1300	2300	1300	3000	3000	1300	1000
Co	30	23	31	10	10	30	30
Cr	9	10	21	10	10	<10	41
Cu	59	54	74	40	15	40	31
Li	12	13	22	<20	<20	<20	25
Ni	10	8	20	15	10	30	26
Pb	18	54	28	10	10	<10	14
Sb				<4	<4		
Zn	120	113	127	130	130	130	106
Be	5	4	5	3	<3	<3	5
Mo	<1	<1	6	<10	<10	<10	<1
Sc	20	20	25	<20	<20	<20	20
Sr	700	1000	600	100	1000	900	800
V	150	100	150	30	10	80	150
Y	30	30	30	30	40	20	20
Ga	15	9	10	10	10	15	10
Nb	150	100	100	300	300	70	100
Rb	90	110	120	40	60	40	100
Zr	250	250	200	250	300	200	200
Sn	<3	4	4	<10	<10	<10	<3
Eu	<100	<100	<100				
Yb	2	2	2				<100
Ce	280	460	270	800	800	700	1
La	<100	<100	<100	80	150	<10	<100
Nd	<100	<100	<100	<300	<300	<300	<100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No. Sample No.
 559 SHR 29-13
 584 SHR 51-55B
 569 SHR 49-3C
 654 AH 19-6

Map No. Sample No.
 651 AH 19-21D
 655 AH 20-17
 566 SHR 49-1

TABLE A-3 continued.

Map No.	UNIT 2H	UNIT 2J			UNIT 2K	MISC	
	560	550	574	610	608	640	650
Ag	<1	<1	<1	<1	<1	<1	<1
As							<1
Ba	320	270	760	350	1800	1300	3000
Co	54	<5	11	5	19	35	20
Cr	39	<5	7	<5	<5	800	15
Cu	138	20	30	50	38	60	50
Li	14	3	8	4	10	7	<20
Ni	39	<5	<5	<5	<5	165	20
Pb	44	17	75	40	17	25	10
Sb							<4
Zn	172	52	98	104	124	84	110
Be	320	5	6	9	7	5	3
Mo	<1	<1	<1	<1	<1	<1	<10
Sc	45	<5	<5	<5	7	30	20
Sr	200	100	300	100	900	700	800
V	700	<10	<10	<10	45	150	150
Y	45	<10	35	30	25	25	20
Ga	15	10	9	15	8	9	10
Nb	50	100	300	250	100	90	100
Rb	40	220	210	220	150	90	30
Zr	200	250	700	800	200	250	250
Sn	5	<3	8	4	<3	<3	<10
Eu	<100	<100	<100	<100	<100	<100	
Yb	4	<1	2	2	1	1	
Ce	380	100	290	240	370	320	<500
La	<100	<100	<100	<100	150	150	45
Nd	<100	<100	<100	<100	<100	<100	<300

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No. Sample No.
 560 SHR 29-15
 550 SHR 51-18B
 574 SHR 51-18A
 610 SHR 52-18C

Map No. Sample No.
 608 SHR 52-18A
 640 X1-1B
 650 AH 19-2A

TABLE A-4. NORMATIVE MINERALS (CIPW NORM) FOR WHOLE-ROCK SAMPLES FROM THE SHENANGO TOWNSHIP ALKALIC ROCK COMPLEX

Samples	UNIT 1					UNIT 2A	
	616	619	624	652	653	551	557
S.G.	2.98	3.00	3.00	2.93	2.98	2.62	2.59
AP	0.38	0.36	0.33	0.19	0.12	0.17	0.12
PO	0.03	0.0	0.0	0.03	0.03	0.03	0.03
IL	2.48	2.56	2.50	1.92	2.36	0.37	0.25
OR	3.98	3.56	2.76	3.50	1.88	32.16	27.87
AB	21.29	19.87	20.14	17.63	10.75	42.12	37.20
AN	26.19	26.96	26.91	29.59	35.30	4.48	3.35
C	0.0	0.0	0.0	0.0	0.0	0.57	1.50
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	5.85	7.14	7.29	5.50	7.19	2.30	1.18
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	9.82	9.64	9.90	9.78	4.86	0.66	0.15
FS	6.66	6.58	5.88	5.23	5.84	1.56	1.39
Q	6.79	5.60	6.84	10.17	17.34	15.59	26.97
DI	10.40	11.13	11.51	11.23	7.01	0.0	0.0
FO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	6.15	6.62	5.96	5.24	7.34	0.0	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

S.G. - Specific Gravity; AP - Apatite; PO - Pyrrhotite; IL - Ilmenite;
 OR - Orthoclase; AB - Albite; AN - Anorthite; C - Corundum;
 AC - Acmite; MT - Magnetite; HM - Hematite; WO - Wollastonite;
 EN - Enstatite; FS - Ferrosilite; Q - Quartz; DI - Diopside;
 FO - Forsterite; FA - Fayalite; NE - Nepheline; LC - Leucite;
 KP - Kaliophilite; HE - Hedenbergite; CC - Calcite; RU - Rutile
 NS - Na₂SiO₃; KS - Kalsilite; CR - Chromite; LN - Larnite.
 Note: For sample descriptions, see Table A-1.

Map No. Sample No.
 616 SHR 63-1A
 619 SHR 63-4
 624 SHR 63-23A
 652 AH 19-3A

Map No. Sample No.
 653 AH 19-5A
 551 SHR 29-2A
 557 SHR 29-12C

TABLE A-4 continued.

Map No.	UNIT 2A			UNIT 2B			
	564	570	601	637	638	635	642
S.G.	2.60	2.63	2.65	2.68	2.66	2.81	2.70
AP	0.07	0.17	0.07	0.47	0.14	1.24	6.47
PO	0.06	0.11	0.03	0.03	0.03	0.06	0.03
IL	0.12	0.31	0.18	0.60	0.56	1.83	0.83
OR	32.43	32.91	28.65	35.86	34.97	21.99	32.49
AB	38.56	43.30	52.01	44.45	50.02	38.82	46.55
AN	4.97	7.32	4.29	8.39	6.89	16.21	5.40
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.58	0.79	4.26	1.97	3.03	3.04	3.63
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.21	0.0	0.0	0.0	0.0
EN	0.05	0.96	0.0	0.0	0.60	2.98	0.0
FS	0.76	1.58	0.0	0.0	2.37	4.21	0.0
Q	21.15	11.11	10.14	0.0	0.0	0.0	0.0
DI	0.00	0.60	0.06	0.56	0.23	2.53	1.07
FO	0.0	0.0	0.0	1.16	0.07	1.56	0.56
FA	0.0	0.0	0.0	4.25	0.32	0.43	2.39
NE	0.0	0.0	0.0	0.61	0.0	0.0	2.95
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	0.06	0.86	0.11	1.63	0.77	3.11	3.63
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
564	SHR 38-4
570	SHR 49-3D
601	SHR 51-107
637	SHW 64-8A

Map No.	Sample No.
638	SHW 64-8B
635	SHW 64-2
642	X2-7

TABLE A-4 continued.

Map No.	UNIT 2B						
	646	556	581	592	595	597	604
S.G.	2.80	2.72	2.72	2.63	2.65	2.66	2.66
AP	0.38	0.31	0.40	0.24	0.29	0.19	0.14
PO	0.03	0.03	0.03	0.03	0.0	0.03	0.03
IL	1.23	1.50	0.60	0.45	0.53	0.35	0.21
OR	37.62	29.01	35.24	43.42	40.66	32.18	34.09
AB	38.39	47.85	35.28	43.00	41.71	52.97	49.21
AN	7.65	9.50	8.43	5.89	6.16	3.36	5.53
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.16	3.44	3.64	2.12	2.20	1.84	3.60
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.01	0.0	0.0	0.0	0.51	0.0
FS	0.0	0.03	0.0	0.0	0.0	2.94	0.0
Q	0.0	0.0	0.0	0.0	0.0	1.73	0.0
DI	0.94	1.54	1.17	0.23	0.63	0.65	0.03
FO	0.45	0.57	0.87	0.43	0.46	0.0	0.03
FA	3.37	1.99	4.11	2.64	2.93	0.0	2.13
NE	1.23	0.0	5.88	0.47	1.25	0.0	2.80
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	5.54	4.23	4.37	1.13	3.19	3.27	2.20
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
646	X4-6
556	SHR 29-12B
581	SHR 51-54
592	SHR 51-74A

Map No.	Sample No.
595	SHR 51-77
597	SHR 51-81B
604	SHR 52-4B

TABLE A-4 continued.

Map No.	UNIT 2B						
	609	618	617	620	623	625	656
S.G.	2.67	2.80	2.75	2.83	2.71	2.72	2.73
AP	0.14	1.11	1.04	1.07	0.23	0.42	0.55
PO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IL	0.29	2.00	1.57	3.05	0.86	1.00	1.67
OR	35.12	24.28	26.52	22.96	33.02	33.90	26.58
AB	51.02	40.47	42.31	40.47	48.79	46.00	42.77
AN	3.48	16.17	12.04	12.61	5.33	6.35	13.61
C	0.0	0.0	0.0	0.0	0.0	0.0	0.93
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.52	5.45	2.58	3.58	4.18	3.33	7.26
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	3.23	0.0	1.25	0.0	0.13	1.83
FS	0.0	4.78	0.0	2.68	0.0	0.60	0.57
Q	0.0	0.01	0.0	0.0	0.0	0.0	4.26
DI	0.02	1.09	1.53	2.35	0.56	0.95	0.0
FO	0.01	0.0	2.57	1.66	0.26	0.58	0.0
FA	2.50	0.0	5.98	3.92	2.47	2.92	0.0
NE	0.69	0.0	1.04	0.0	0.13	0.0	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	4.20	1.41	2.82	4.39	4.18	3.83	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
609	SHR 52-18B
618	SHR 63-2B
617	SHR 63-2A
620	SHR 63-8

Map No.	Sample No.
623	SHR 63-20A
625	SHR 63-23B
656	SH1 100-100.5

TABLE A-4 continued.

Map No.	UNIT 2B						
	657	658	659	660	661	662	663
S.G.	2.71	2.71	2.72	2.71	2.69	2.75	2.74
AP	0.33	0.38	0.42	0.43	0.33	0.57	0.52
PO	0.03	0.03	0.0	0.11	0.03	0.06	0.06
IL	1.24	1.37	1.00	1.34	1.05	1.81	1.67
OR	38.97	35.26	33.90	41.38	41.72	33.78	35.39
AB	38.71	36.39	46.00	34.49	34.02	38.94	40.24
AN	7.15	11.62	6.35	11.04	7.05	13.50	8.69
C	0.0	0.25	0.0	2.05	0.0	0.06	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	4.82	6.44	3.33	2.51	2.52	3.23	2.60
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.60	1.09	0.13	1.23	0.85	0.0	1.23
FS	1.55	1.42	0.60	3.85	3.79	0.0	4.82
Q	2.95	5.75	0.0	0.0	6.13	0.0	0.0
DI	1.12	0.0	0.95	0.0	0.52	0.0	0.91
FO	0.0	0.0	0.58	0.35	0.0	1.34	0.15
FA	0.0	0.0	2.92	1.21	0.0	5.30	0.63
NE	0.0	0.0	0.0	0.0	0.0	1.42	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.54	0.0	3.83	0.0	2.00	0.0	3.11
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
657	SH1 416.3-416.8
658	SH1 479.1-479.5
659	SH2 105.1-105.6
660	SH2 162.4-162.8

Map No.	Sample No.
661	SH2 248.3-248.6
662	SH2 296.25-296.4
663	SH2 300.5-301.0

TABLE A-4 continued.

Map No.	UNIT 2B				UNIT 2C		
	664	643	567	583	631	632	645
S.G.	2.70	2.79	2.68	2.64	2.86	2.82	2.93
AP	0.26	1.02	0.14	0.48	1.65	1.45	2.30
PO	0.06	0.06	0.06	0.03	0.11	0.03	0.08
IL	1.19	2.44	0.48	0.25	3.32	2.63	3.38
OR	29.68	32.09	31.68	33.75	18.17	18.12	12.89
AB	43.37	37.45	55.23	55.16	31.31	33.96	30.70
AN	11.78	9.36	2.09	1.55	15.91	23.20	22.42
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	6.36	5.46	3.45	2.63	3.48	2.21	3.86
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.45	1.37	0.0	0.0	0.0	0.0	0.0
FS	0.50	4.50	0.0	0.0	0.0	0.0	0.0
Q	0.0	1.02	0.0	0.0	0.0	0.0	0.0
DI	0.47	1.36	0.16	1.03	4.06	2.19	4.12
FO	0.19	0.0	0.04	0.11	4.17	3.83	4.89
FA	0.23	0.0	1.48	0.48	7.00	5.35	7.98
NE	0.0	0.0	0.10	1.37	5.42	4.61	2.08
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	0.46	3.89	5.09	3.51	5.40	2.42	5.31
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
664	SH2 365.5-366.0
643	X4-1
567	SHR 49-3A
583	SHR 51-55

Map No.	Sample No.
631	SHW 37-10A
632	SHW 37-12
645	X4-3C

TABLE A-4 continued.

Map No.	UNIT 2C						
	647	562	563	561	565	573	572
S.G.	3.00	2.78	2.73	2.78	2.79	2.81	2.80
AP	2.30	0.90	0.74	1.16	1.20	1.61	1.35
PO	0.14	0.06	0.03	0.03	0.03	0.03	0.0
IL	2.74	1.94	1.44	2.19	2.13	2.27	2.35
OR	9.76	16.18	26.32	23.81	21.89	19.34	14.90
AB	29.47	41.57	41.39	36.57	35.27	30.66	34.29
AN	24.80	25.37	19.33	18.33	22.19	25.77	28.89
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.0	1.64	1.53	1.76	2.39	2.19	1.80
HM	14.58	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	6.69	0.0	0.0	4.77	0.0	0.0	0.0
FS	0.0	0.0	0.0	7.04	0.0	0.0	0.0
Q	0.26	0.0	0.0	0.49	0.0	0.0	0.0
DI	8.14	1.74	1.37	1.69	1.85	2.01	2.10
FO	0.0	2.71	2.25	0.0	4.65	4.54	3.97
FA	0.0	3.80	3.60	0.0	5.14	5.52	4.91
NE	0.0	2.18	0.27	0.0	1.64	4.13	3.39
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	0.0	1.92	1.74	2.17	1.62	1.94	2.05
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	1.11	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
647	X4-8
562	SHR 36-9
563	SHR 38-3
561	SHR 36-8

Map No.	Sample No.
565	SHR 38-5B
573	SHR 51-10
572	SHR 51-2B

TABLE A-4 continued.

Map No.	UNIT 2C						
	576	578	577	579	580	582	585
S.G.	2.85	2.83	2.83	2.81	2.78	2.82	2.86
AP	1.69	1.43	1.48	1.43	0.81	1.20	2.00
PO	0.03	0.03	0.03	0.03	0.03	0.03	0.03
IL	3.03	2.73	2.40	2.24	2.64	2.69	3.41
OR	26.41	16.26	16.76	14.42	20.25	18.19	18.28
AB	21.81	32.31	29.49	28.91	33.15	24.20	23.36
AN	18.48	26.58	25.77	30.91	28.20	31.18	28.03
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.68	2.45	2.37	3.34	3.77	3.85	2.11
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	2.31	2.22	2.60	2.38	0.03	1.76	3.17
FO	6.20	3.81	4.37	3.91	3.86	4.46	4.96
FA	7.55	5.47	5.69	4.20	3.42	4.11	6.11
NE	6.57	4.22	6.38	6.22	3.83	7.05	5.46
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.23	2.52	2.67	2.02	0.02	1.29	3.09
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
576	SHR 51-37
578	SHR 51-43
577	SHR 51-40
579	SHR 51-50A

Map No.	Sample No.
580	SHR 51-52
582	SHR 51-54B
585	SHR 51-55D

TABLE A-4 continued.

Map No.	UNIT 2C						
	586	588	589	590	591	593	594
S.G.	2.89	2.81	2.80	2.81	2.91	2.80	2.77
AP	2.53	1.16	1.22	1.36	3.84	1.26	1.26
PO	0.03	0.03	0.03	0.03	0.06	0.03	0.0
IL	3.97	2.54	2.33	2.00	2.63	1.95	1.86
OR	22.80	21.51	21.18	14.54	10.40	20.25	22.27
AB	20.13	31.84	34.53	35.08	22.52	33.04	31.78
AN	21.77	17.32	22.85	30.02	36.82	23.14	23.78
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.56	1.87	3.06	1.83	2.82	2.62	0.51
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	2.46	4.59	2.58	1.32	1.24	1.33	0.85
FO	5.88	3.54	3.68	2.93	6.60	3.43	2.99
FA	7.24	5.08	4.44	5.08	8.68	5.68	7.20
NE	7.23	5.32	1.59	4.00	3.11	5.55	5.88
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.40	5.21	2.46	1.80	1.29	1.74	1.62
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
586	SHR 51-57
588	SHR 51-63B
589	SHR 51-65A
590	SHR 51-67A

Map No.	Sample No.
591	SHR 51-71B
593	SHR 51-74B
594	SHR 51-76

TABLE A-4 continued.

Map No.	UNIT 2C						
	596	598	599	600	602	603	605
S.G.	2.75	2.72	2.81	2.79	2.86	2.84	2.63
AP	0.81	0.76	1.54	1.10	2.31	1.85	0.07
PO	0.0	0.0	0.06	0.03	0.03	0.06	0.0
IL	1.25	1.43	2.49	1.88	2.82	2.78	0.14
OR	24.58	33.86	24.82	25.29	20.12	14.23	28.79
AB	34.33	35.29	26.65	29.30	24.00	27.57	44.27
AN	20.89	17.21	21.73	22.49	25.78	30.94	3.63
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.79	1.64	2.85	2.31	2.66	2.63	0.49
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.02
FS	0.0	0.0	0.0	0.0	0.0	0.0	2.68
Q	0.0	0.0	0.0	0.0	0.0	0.0	18.72
DI	1.85	0.63	2.54	1.01	2.38	2.93	0.01
FO	2.05	1.16	3.91	3.08	4.98	4.57	0.0
FA	3.69	4.02	5.62	6.57	7.04	5.34	0.0
NE	6.14	2.26	4.89	5.24	5.22	4.40	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.64	1.73	2.90	1.70	2.66	2.71	1.19
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
596	SHR 51-81A
598	SHR 51-87
599	SHR 51-90
600	SHR 51-94

Map No.	Sample No.
602	SHR 52-2B
603	SHR 52-4A
605	SHR 52-11A

TABLE A-4 continued.

Map No.	UNIT 2C						
	606	611	607	612	613	614	615
S.G.	2.75	2.85	2.84	2.81	2.68	2.73	2.68
AP	0.81	1.85	1.88	1.70	0.59	0.80	0.57
PO	0.0	0.08	0.06	0.03	0.03	0.03	0.0
IL	1.67	1.83	2.74	2.05	1.50	1.62	1.14
OR	24.23	10.35	14.65	14.41	42.59	28.06	43.29
AB	39.90	29.01	24.50	33.73	36.15	42.26	36.38
AN	19.40	35.55	29.19	28.08	10.36	15.39	10.38
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.81	1.99	2.66	2.38	1.74	2.74	2.43
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.79
FS	0.0	0.0	0.0	0.0	0.0	0.0	2.26
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	1.79	3.59	2.72	3.54	0.88	1.50	0.39
FO	2.65	3.44	3.79	3.44	1.27	1.55	0.34
FA	3.84	4.24	5.24	3.87	3.13	2.78	1.07
NE	1.86	3.56	4.61	3.64	0.04	1.13	0.0
IC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.04	3.51	2.98	3.15	1.72	2.13	0.98
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
606	SHR 52-11B
611	SHR 52-18E
607	SHR 52-16
612	SHR 52-19

Map No.	Sample No.
613	SHR 52-29
614	SHR 52-35
615	SHR 52-37

TABLE A-4 continued.

Map No.	UNIT 2C			UNIT 2D			
	621	622	649	627	628	629	630
S.G.	2.90	2.84	2.80	2.84	2.85	2.84	2.87
AP	1.64	1.14	0.97	1.43	1.72	1.62	1.30
PO	0.06	0.03	0.03	0.03	0.03	0.06	0.08
IL	3.34	3.01	1.75	2.12	2.19	2.05	1.88
OR	14.17	19.23	15.19	22.11	21.29	21.87	17.90
AB	37.37	39.28	36.18	31.97	28.98	29.07	26.70
AN	20.27	12.99	33.23	18.04	19.13	20.61	22.59
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.21	3.74	1.45	2.39	2.54	3.08	2.58
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	1.72	0.0	0.0	0.0	0.0
FS	0.0	0.0	2.81	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	3.40	3.08	0.37	3.23	3.23	2.86	5.76
FO	4.04	2.64	2.06	4.22	4.21	5.11	5.41
FA	7.33	5.75	3.71	7.20	7.06	6.92	6.22
NE	0.21	3.80	0.0	2.91	5.34	3.70	4.32
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	4.88	5.32	0.53	4.35	4.29	3.06	5.25
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
621	SHR 63-15
622	SHR 63-18
649	AG 20-10
627	SHW 1-8

Map No.	Sample No.
628	SHW 20-5A
629	SHW 20-5B
630	SHW 37-4A

TABLE A-4 continued.

Map No.	UNIT 2D						
	571	633	636	626	641	644	648
S.G.	2.86	2.81	2.85	2.83	2.81	2.80	2.71
AP	1.04	1.47	1.73	1.28	1.04	0.86	0.31
PO	0.03	0.03	0.03	0.11	0.03	0.03	0.06
IL	1.49	2.18	2.35	1.84	2.66	0.62	1.01
OR	16.13	23.98	21.92	22.03	21.29	16.13	35.12
AB	28.51	35.90	31.71	34.73	38.67	41.12	43.56
AN	26.96	15.82	15.80	18.17	20.46	19.15	6.26
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.11	2.79	1.91	2.89	3.74	3.60	4.13
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	1.92	0.0	0.44
FS	0.0	0.0	0.0	0.0	3.17	0.0	3.11
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	6.67	2.17	2.97	3.12	0.96	1.99	0.79
FO	5.04	3.76	3.99	4.22	1.67	2.79	0.04
FA	5.12	6.37	7.92	6.06	3.03	5.71	0.30
NE	1.53	2.65	5.00	2.00	0.0	4.80	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	5.36	2.90	4.67	3.55	1.38	3.22	4.87
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
571	SHW 50-10
633	SHW 50-9
636	SHW 64-4
626	SHW 64-12

Map No.	Sample No.
641	X1-4
644	X4-3B
648	X4-10

TABLE A-4 continued.

Map No.	UNIT 2D						
	548	549	552	558	553	555	554
S.G.	2.85	2.85	2.82	2.81	2.80	2.81	2.88
AP	1.26	1.34	1.09	1.41	1.28	1.28	1.12
PO	0.08	0.11	0.03	0.11	0.06	0.03	0.08
IL	1.89	1.80	1.49	1.87	1.61	1.86	1.44
OR	20.14	18.84	22.64	23.83	23.62	23.22	16.53
AB	28.50	30.48	32.44	32.98	37.21	36.67	29.16
AN	22.58	20.65	18.18	19.30	15.19	17.59	22.20
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.66	3.05	2.80	2.86	2.93	2.96	1.54
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	4.45	5.31	5.02	2.64	3.14	2.57	6.59
FO	5.95	5.13	4.91	3.82	3.67	3.91	5.72
FA	6.35	5.57	5.47	5.51	5.50	5.66	6.16
NE	2.38	3.17	1.51	2.67	2.08	1.31	3.86
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.76	4.56	4.43	3.01	3.72	2.94	5.61
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
548	SHR 1-1
549	SHR 1-7
552	SHR 29-2B
558	SHR 29-12F

Map No.	Sample No.
553	SHR 29-3
555	SHR 29-12A
554	SHR 29-9

TABLE A-4 continued.

Map No.	UNIT 2D						
	559	584	569	654	651	655	566
S.G.	2.86	2.89	2.88	2.72	2.76	2.86	2.89
AP	1.24	1.84	1.14	0.75	0.25	0.38	1.11
PO	0.03	0.20	0.25	0.03	0.03	0.20	0.03
IL	1.96	2.86	1.79	1.18	0.75	1.89	1.67
OR	17.54	21.45	17.97	30.05	25.04	18.40	16.05
AB	28.92	22.57	24.60	42.81	38.16	24.64	20.13
AN	24.66	25.30	21.77	7.20	10.82	26.21	30.38
C	0.0	0.0	0.0	0.0	2.53	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.06	3.02	2.11	3.45	4.30	4.97	2.41
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.94	2.29	0.0	0.0
FS	0.0	0.0	0.0	2.28	8.41	0.0	0.0
Q	0.0	0.0	0.0	0.0	7.41	0.0	0.0
DI	4.63	2.81	7.88	2.71	0.0	5.05	6.56
FO	5.11	4.91	5.33	0.78	0.0	3.70	5.70
FA	6.09	6.94	5.54	2.09	0.0	4.93	5.42
NE	2.40	4.96	5.14	0.0	0.0	4.31	5.60
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	4.37	3.14	6.48	5.75	0.0	5.33	4.93
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
559	SHR 29-13
584	SHR 51-55B
569	SHR 49-3C
654	AH 19-6

Map No.	Sample No.
651	AH 19-2D
655	AH 20-17
566	SHR 49-1

TABLE A-4 continued.

Map No.	UNIT 2H	UNIT 2J			UNIT 2K	MISC	
	560	550	574	610	608	640	650
S.G.	3.09	2.59	2.72	2.64	2.83	2.98	2.85
AP	0.47	0.07	0.47	0.07	1.47	0.93	1.71
PO	1.64	0.08	0.03	0.14	0.06	0.03	0.06
IL	0.35	0.10	0.81	0.12	1.91	1.45	1.78
OR	7.27	37.39	40.10	31.75	26.59	16.93	13.30
AB	21.76	52.89	32.67	55.53	28.76	16.07	33.69
AN	18.66	3.61	8.26	5.38	18.36	16.67	29.32
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.0	1.23	3.39	2.48	2.97	3.93	6.93
HM	16.67	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	1.89	0.0	0.0	0.0	0.0	0.0	2.35
FS	0.0	0.0	0.0	0.0	0.0	0.0	1.46
Q	7.31	0.0	0.0	0.0	0.0	0.0	1.27
DI	21.10	0.02	0.97	0.02	1.45	22.04	5.50
FO	0.0	0.01	1.00	0.01	3.17	8.61	0.0
FA	0.0	1.05	4.16	1.97	7.62	2.88	0.0
NE	0.0	2.47	4.94	0.73	4.88	4.65	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	0.0	1.09	3.20	1.82	2.76	5.83	2.97
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	2.89	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Map No.	Sample No.
560	SHR 29-15
550	SHR 51-18B
574	SHR 51-18A
610	SHR 52-18C

Map No.	Sample No.
608	SHR 52-18A
640	X1-1B
650	AH 19-2A

TABLE A-5. AVERAGE CHEMICAL COMPOSITIONS OF LITHOLOGIC UNITS FOR THE SHENANGO TOWNSHIP ALKALIC ROCK COMPLEX

UNIT 1C (N = 5)				
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO ₂	51.9	50.3	1.18	53.2
Al ₂ O ₃	14.4	14.1	0.39	15.0
Fe ₂ O ₃	4.46	3.71	0.58	4.96
FeO	7.90	6.65	0.73	8.53
MgO	5.34	3.18	1.21	6.04
CaO	9.87	9.40	0.36	10.4
Na ₂ O	2.08	1.24	0.50	2.47
K ₂ O	0.52	0.31	0.14	0.66
H ₂ O +	0.70	0.32	0.45	1.48
H ₂ O -	0.19	0.03	0.14	0.35
CO ₂	0.18	0.14	0.03	0.22
TiO ₂	1.22	0.99	0.14	1.32
P ₂ O ₅	0.12	0.05	0.05	0.16
S	0.00	0.01	0.00	0.01
MnO	0.21	0.20	0.01	0.22
Ag	1	1	0	1
As	3	1	2	4
Ba	188	150	38	240
Be	2	1	1	3
Bi				
Co	47	30	11	60
Cr	105	80	18	130
Cu	72	30	48	150
Ga	13	10	3	15
Hg				
Li	13	6	7	20
Mn				
Mo	45	1	5	10
Nb	22	10	11	30
Ni	84	80	9	100
Pb	11	10	2	15
Rb	14	10	5	20
Sb	4	4	0	4
Sc	31	20	7	35
Sn	6	3	4	10
Sr	200	200	0	200
V	312	10	204	500
Y	37	20	15	60
Zn	125	110	16	150
Zr	180	150	45	250
Ce	330	200	156	500
La	64	10	49	100
Nd	180	100	110	300

Notes: For complete listing of statistical parameters, see Open File Report 5415. Additions to analytical data in Tables A-2 to A-4, made in 1987, have not been incorporated in Table A-5. Recalculation of statistical data in 1987 gave similar but not identical results.

TABLE A-5 continued.

UNIT 2A (N = 5)				
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO ₂	68.0	64.8	2.73	71.5
Al ₂ O ₃	15.8	14.8	0.92	16.9
Fe ₂ O ₃	1.37	0.54	0.92	2.87
FeO	1.37	1.05	0.25	1.69
MgO	0.17	0.01	0.21	0.49
CaO	1.13	0.73	0.44	1.89
Na ₂ O	4.95	4.32	0.65	5.99
K ₂ O	5.11	4.63	0.41	5.49
H ₂ O +	0.12	0.03	0.10	0.29
H ₂ O -	0.31	0.15	0.13	0.51
CO ₂	0.32	0.22	0.06	0.36
TiO ₂	0.13	0.06	0.05	0.19
P ₂ O ₅	0.05	0.03	0.02	0.07
S	0.02	0.01	0.01	0.04
MnO	0.04	0.03	0.01	0.06
Ag	1	1	0	1
As				
Ba	464	110	488	1300
Be	11	9	3	15
Bi				
Co	6	5	2	9
Cr	5	5	0	5
Cu	17	5	14	35
Ga	16	15	2	20
Hg				
Li	6	3	3	10
Mn				
Mo	1	1	0	1
Nb	160	100	42	200
Ni	5	5	0	5
Pb	32	20	10	45
Rb	210	170	47	290
Sb				
Sc	5	5	0	5
Sn	3	3	0	3
Sr	177	35	114	350
V	14	10	7	25
Y	44	25	18	70
Zn	49	30	14	70
Zr	330	200	186	600
Ce	178	90	74	290
La	100	100	0	100
Nd	100	100	0	100

Notes: For complete listing of statistical parameters, see Open File Report 5415.

TABLE A-5 continued.

UNIT 2B (N = 29)				
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO ₂	58.5	52.6	2.50	63.2
Al ₂ O ₃	17.7	16.1	0.84	19.9
Fe ₂ O ₃	2.41	1.25	0.96	4.90
FeO	4.35	2.17	1.33	7.81
MgO	0.66	0.01	0.58	2.50
CaO	2.75	1.41	1.00	5.20
Na ₂ O	5.20	3.94	0.75	6.68
K ₂ O	5.53	3.18	0.95	7.17
H ₂ O +	0.32	0.05	0.19	0.82
H ₂ O -	0.40	0.25	0.09	0.62
CO ₂	0.27	0.15	0.09	0.52
TiO ₂	0.60	0.11	0.36	1.55
P ₂ O ₅	0.20	0.05	0.14	0.52
S	0.01	0.01	0.01	0.04
MnO	0.16	0.09	0.04	0.23
Ag	1	1	0	1
As				
Ba	1461	50	1061	3600
Be	6	1	3	15
Bi				
Co	8	5	4	20
Cr	6	5	4	25
Cu	25	6	19	80
Ga	14	9	2	15
Hg				
Li	8	3	4	20
Mn				
Mo	1	1	1	7
Nb	183	25	80	400
Ni	5	5	0	5
Pb	30	15	13	75
Rb	163	60	59	320
Sb				
Sc	10	5	5	25
Sn	3	3	0	4
Sr	282	15	164	700
V	17	10	27	150
Y	42	30	7	60
Zn	114	70	26	175
Zr	588	200	300	1500
Ce	385	240	116	670
La	181	100	83	450
Nd	114	100	32	200

Notes: For complete listing of statistical parameters, see Open File Report 5415.

TABLE A-5 continued.

UNIT 2C (N = 41)				
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO ₂	51.9	44.6	4.37	70.2
Al ₂ O ₃	19.4	15.0	1.56	21.7
Fe ₂ O ₃	1.93	0.33	2.10	14.4
FeO	5.78	1.14	1.78	9.58
MgO	2.41	0.01	0.93	4.15
CaO	6.46	1.03	1.78	9.91
Na ₂ O	4.46	3.23	0.48	5.28
K ₂ O	3.40	1.63	1.25	7.20
H ₂ O +	0.48	0.08	0.24	0.99
H ₂ O -	0.38	0.04	0.11	0.69
CO ₂	0.26	100.0	0.66	0.40
TiO ₂	1.20	0.07	0.43	2.52
P ₂ O ₅	0.60	0.03	0.28	1.60
S	0.02	0.01	0.01	0.05
MnO	0.14	0.06	0.04	0.25
Ag	1	1	0	1
As	1	1	0	1
Ba	2374	100	1042	4900
Be	4	1	3	15
Bi				
Co	19	5	7	40
Cr	19	5	15	80
Cu	29	9	12	70
Ga	11	7	3	15
Hg				
Li	14	4	5	25
Mn				
Mo	1	1	1	10
Nb	94	30	48	250
Ni	11	5	9	50
Pb	17	10	13	70
Rb	104	40	52	340
Sb	4	4	0	4
Sc	11	5	4	25
Sn	3	3	1	10
Sr	977	80	316	1500
V	74	10	36	150
Y	22	10	5	35
Zn	93	35	28	200
Zr	171	60	74	400
Ce	402	120	136	690
La	106	40	29	250
Nd	105	100	32	300

Notes: For complete listing of statistical parameters, see Open File Report 5415.

TABLE A-5 continued.

UNIT 2D (N = 25)				
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO ₂	52.6	48.2	3.19	60.4
Al ₂ O ₃	17.8	16.4	0.75	19.6
Fe ₂ O ₃	2.02	1.04	0.54	3.37
FeO	6.70	4.75	0.83	8.29
MgO	2.89	0.34	1.19	4.42
CaO	6.17	2.35	1.84	9.38
Na ₂ O	4.35	3.53	0.53	5.76
K ₂ O	3.63	2.66	0.85	5.80
H ₂ O +	0.59	0.08	0.29	1.39
H ₂ O -	0.32	0.04	0.10	0.46
CO ₂	0.28	0.10	0.11	0.50
TiO ₂	0.90	0.32	0.27	1.46
P ₂ O ₅	0.48	0.11	0.18	0.77
S	0.03	0.01	0.02	0.09
MnO	0.19	0.15	0.04	0.29
Ag	1	1	0	1
As	1	1	0	1
Ba	1731	400	1353	7700
Be	5	1	2	7
Bi				
Co	24	5	8	30
Cr	12	5	10	40
Cu	40	15	16	75
Ga	12	7	3	15
Hg				
Li	16	4	6	25
Mn				
Mo	3	1	5	20
Nb	139	60	74	350
Ni	12	5	8	30
Pb	32	10	21	95
Rb	109	40	36	180
Sb	4	4	0	4
Sc	17	8	4	25
Sn	4	3	2	10
Sr	669	150	227	1000
V	116	10	57	200
Y	28	10	8	40
Zn	114	85	22	195
Zr	267	100	128	700
Ce	442	160	195	830
La	111	10	40	250
Nd	129	100	70	300

Notes: For complete listing of statistical parameters, see Open File Report 5415.

TABLE A-5 continued.

UNIT 2J (N = 3)				
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO ₂	60.5	56.9	3.18	62.9
Al ₂ O ₃	18.6	18.2	0.40	19.0
Fe ₂ O ₃	1.60	0.83	0.74	2.30
FeO	3.06	1.45	1.84	5.07
MgO	0.25	0.01	0.42	0.74
CaO	1.79	1.00	0.96	2.86
Na ₂ O	6.04	4.86	1.03	6.67
K ₂ O	6.05	5.27	0.71	6.67
H ₂ O +	0.24	0.13	0.14	0.39
H ₂ O -	0.38	0.28	0.09	0.46
CO ₂	0.28	0.26	0.04	0.32
TiO ₂	0.18	0.05	0.21	0.42
P ₂ O ₅	0.09	0.03	0.10	0.20
S	0.03	0.01	0.02	0.05
MnO	0.12	0.07	0.05	0.16
Ag	1	1	0	1
As				
Ba	460	270	263	760
Be	7	5	2	9
Bi				
Co	7	5	3	10
Cr	6	5	1	7
Cu	33	20	15	50
Ga	11	3	3	15
Hg				
Li	5	3	3	2
Mn				
Mo	1	1	0	1
Nb	217	100	104	300
Ni	5	5	0	5
Pb	43	15	30	75
Rb	217	210	6	220
Sb				
Sc	5	5	0	5
Sn	5	3	3	8
Sr	167	100	115	300
V	10	10	0	10
Y	25	10	13	35
Zn	85	50	30	105
Zr	583	250	293	800
Ce	210	100	98	290
La	100	100	0	100
Nd	100	100	0	100

Notes: For complete listing of statistical parameters, see Open File Report 5415.

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Index

- Aeromagnetic data 28
 - Amphibolite 10
 - Figure 29
 - Map 7
- AFM plots 24
 - Figures 25
- Amphibole
 - Basalt xenoliths (amphibolite)
 - Chemical analyses 12
 - Monzonitic rocks 8
 - Quartz monzonite to granite 20
 - Syenite dike 22
- Amphibole (hornblende)
 - Diorite to monzonite, coarse-grained 17, 18
 - Diorite to monzonite, fine-grained 15
 - Diorite porphyry 14
 - Gneiss, hornblende 9
 - Gneiss, quartzitic 9
 - Monzonite to quartz monzonite 19
 - Pegmatite dike 22
 - Syenite dikes, porphyritic 23
 - see also Hornblende
- Amphibolite 8, 24, 28
 - AFM plots 25
 - Chemical analyses 12-13
 - Average composition 105
 - Major element 65
 - Normative minerals (CIPW) 89
 - Trace element 73
 - Copper 31
 - Metamorphism 27
 - Petrography 10-11, 52, 53, 54, 62
 - Photo 8
- Amygdules
 - Amphibolite 11
- Analyses, average chemical compositions
 - Amphibolite 105
 - Diorite to monzonite, coarse-grained 108
 - Diorite to monzonite, fine-grained 109
 - Monzonite to quartz monzonite 107
 - Pegmatite, quartz-hornblende monzonite 110
 - Quartz monzonite to granite 106
- Analyses, electron microprobe
 - Basalt xenoliths
 - Amphiboles 12
 - Plagioclase 13
 - Pyroxene 12
 - Diorite
 - Plagioclase 18
 - Pyroxene 18
 - Hornfelsic rocks
 - Biotite 13
- Analyses, major element
 - Amphibolite 65
 - Diorite to monzonite, coarse-grained 67-70
 - Diorite to monzonite, fine-grained 70-72
 - Lamprophyre 72
 - Monzonite to quartz monzonite 65-67
 - Pegmatite, quartz-hornblende monzonite 72
 - Quartz monzonite to granite 65
 - Syenite, plagioclase, biotite, porphyritic 72
- Analyses, normative minerals (CIPW)
 - Amphibolite 89
 - Diorite to monzonite, coarse-grained 94-100
 - Diorite to monzonite, fine-grained 100-103
 - Lamprophyre 104
 - Monzonite to quartz monzonite 90-94
 - Pegmatite, quartz-hornblende monzonite 104
 - Quartz monzonite to granite 89-90
 - Syenite, plagioclase, biotite, porphyritic 104
- Analyses, trace element
 - Amphibolite 73
 - Diorite to monzonite, coarse-grained 78-84
 - Diorite to monzonite, fine-grained 84-87
 - Lamprophyre 88
 - Monzonite to quartz monzonite 74-78
 - Pegmatite, quartz-hornblende monzonite 88
 - Quartz monzonite to granite 73-74
 - Syenite, plagioclase, biotite, porphyritic 88
- Apatite
 - Diorite to monzonite, coarse-grained 17
 - Diorite to monzonite, fine-grained 15
 - Porphyritic syenite dikes 23
- Banding 28
 - Amphibolite 10, 11
 - Gneiss
 - Photo 8
- Barium 6
- Barry Lake 6, 14, 17, 19, 29
- Basalt xenoliths
 - Chemical analyses
 - Amphiboles 12
 - Plagioclase 13
 - Pyroxene 12
- Belford-Strachan metavolcanic-sedimentary belt 11
- Bent crystals
 - Biotite
 - Diorite to monzonite, coarse-grained 17, 18

- Plagioclase
 - Diorite to monzonite, coarse-grained 17, 18
 - Diorite to monzonite, fine-grained 17
- Biotite
 - Amphibolite 11
 - Diorite to monzonite, coarse-grained 17, 18
 - Diorite to monzonite, fine-grained 15, 16
 - Diorite porphyry 14
 - Gabbro 21
 - Garnetiferous gneiss 10
 - Hornblende gneiss 9
 - Hornfelsic rocks
 - Chemical analyses 13
 - Monzonite to quartz monzonite 19, 20
 - Quartz monzonite to granite 20
 - Quartzitic gneiss 9
 - Syenite dike 22, 23
 - Porphyritic 23
- Bollo and Cone Hills 30
- Breccia
 - Diorite to monzonite, fine-grained 28
 - Syenodiorite
 - Photo 15, 16
- Cancrinite
 - Syenite dike 23
- Chemical analyses
 - See Analyses
- Clinopyroxene
 - Garnetiferous gneiss 10
- Contacts
 - Hornfels (amphibolite) 11
 - Monzonite to quartz monzonite 19
 - Quartz monzonite to granite 20
 - Photo 21
- Copper 31
- Diamond drilling 31
- Dikes
 - Gabbro
 - Petrography 21
 - Lamprophyre 23-24
 - Pegmatite
 - Petrography 10, 21-22
 - Photo 22
 - Plagioclase, biotite, porphyritic syenite
 - Petrography 23
 - Quartz monzonite to granite 20
 - Syenite
 - Petrography 22-23
- Dikes/fractures
 - Diorite to monzonite, fine-grained 14, 28
 - Photo 15, 16
- Diorite
 - Chemical analyses
 - Major element 68, 69, 70, 72
 - Normative minerals (CIPW) 96, 97, 98, 99, 100
 - Trace element 80, 81, 82, 83, 84, 88
 - Coarse-grained
 - Photo 16
 - Petrography 41, 42, 43-44, 44-45, 46, 49-50, 61
 - Photo 21, 22
 - Diorite to monzonite, coarse-grained 6, 24, 28
 - AFM plots 25
 - Chemical analyses 18
 - Average composition 108
 - Major element 67-70
 - Normative minerals (CIPW) 94-100
 - Trace element 78-84
 - Petrography 17-19
 - Photo 16
 - Diorite to monzonite, fine-grained 6, 7, 24
 - AFM plots 25
 - Chemical analyses
 - Average composition 109
 - Major element 70-72
 - Normative minerals (CIPW) 100-103
 - Trace element 84-87
 - Internal structures 28
 - Petrography 14-17
 - Photo 15, 16
 - Diorite, amphibole-pyroxene-biotite
 - Chemical analyses
 - Major element 72
 - Normative minerals (CIPW) 103
 - Trace element 87
 - Petrography 36
 - Diorite aplite 23
 - Diorite, biotite-amphibole
 - Chemical analyses
 - Major element 70
 - Normative minerals (CIPW) 100
 - Trace element 84
 - Petrography 56
 - Diorite, biotite-pyroxene
 - Chemical analyses
 - Major element 67, 68, 70, 71
 - Normative minerals (CIPW) 94, 95, 99, 102
 - Trace element 78, 79, 83, 86
 - Petrography 34-35, 51, 60
 - Diorite, olivine
 - Chemical analyses
 - Major element 69
 - Normative minerals (CIPW) 97
 - Trace element 81
 - Petrography 45
 - Diorite, perthite-bearing
 - Chemical analyses
 - Major element 69
 - Normative minerals (CIPW) 97
 - Trace element 81
 - Petrography 43, 45
 - Diorite, perthite-bearing, amphibole-biotite
 - Chemical analyses
 - Major element 68

- Normative minerals (CIPW) 96
- Trace element 80
- Petrography 41-42
- Diorite, perthite-bearing, amphibole-
pyroxene-biotite
- Chemical analyses
 - Major element 70
 - Normative minerals (CIPW) 99
 - Trace element 83
- Petrography 51
- Diorite, perthite-bearing, biotite-amphibole
- Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 94
 - Trace element 78
- Petrography 56
- Diorite, perthite-bearing, biotite-pyroxene
- Chemical analyses
 - Major element 70,71
 - Normative minerals (CIPW) 100,101
 - Trace element 84,85
- Petrography 39,53-54
- Diorite, perthite-bearing, pyroxene-amphibole-biotite
- Chemical analyses
 - Major element 71
 - Normative minerals (CIPW) 102
 - Trace element 86
- Petrography 33
- Diorite porphyry
- Petrography 14
- Diorite, pyroxene
- Chemical analyses
 - Major element 65,72
 - Normative minerals (CIPW) 90,103
 - Trace element 74,87
- Petrography 39
- Diorite, pyroxene-amphibole-biorite
- Chemical analyses
 - Major element 71
 - Normative minerals (CIPW) 102
 - Trace element 86
- Petrography 33
- Diorite, pyroxene-biotite
- Chemical analyses
 - Major element 68,69
 - Normative minerals (CIPW) 95,98
 - Trace element 79,82
- Petrography 39-40,48
- Economic geology 31
- Epidote
 - Amphibolite 8,11
- Feldspar
 - Monzonite to quartz monzonite pegma-
tite dikes 21
 - Syenite dikes 22,23
 - Porphyritic 23
- Fluorite
 - Syenite dike 22
- Foliation 27
- Fork Lake 14,17,19,29
- Fractures
 - Syenodiorite 14
 - Photo 15
- Gabbro
 - Chemical analyses
 - Major element 72
 - Normative minerals (CIPW) 104
 - Trace element 88
 - Petrography 21,36,58-59
- Gabbro, biotite-amphibole
- Chemical analyses
 - Major element 72
 - Normative minerals (CIPW) 103
 - Trace element 87
- Petrography 38
- Gabbro, perthite-bearing, biotite-amphibole-pyroxene
- Chemical analyses
 - Major element 69
 - Normative minerals (CIPW) 98
 - Trace element 82
- Petrography 48
- Garnet
 - Garnetiferous gneiss 10
- Genesco Resources Ltd. 31
- Geochronology 26-27
- Figure
 - Rb/Sr isochron plot 26
- Table
 - K-Ar (biotite) isotopic ages 27
- Gneiss, banded
 - Photo 8
 - see also Orthogneiss
 - Paragneiss
- Gneiss, garnet-quartz-hornblende-plagioclase
 - Petrography 10
- Gneiss, garnetiferous
 - Petrography 10
- Gneiss, hornblende
 - Petrography 9
- Gneiss, hornblende-garnet-plagioclase
 - Petrography 10
- Gneiss, quartz-biotite-hornblende-plagioclase
 - Petrography 9
- Gneiss, quartz-hornblende-plagioclase
 - Petrography 9
- Gneiss, quartzitic
 - Petrography 9
- Gneissic rock 27
- Granitic rock 8
- Granodiorite aplite
 - Chemical analyses
 - Major element 65
 - Normative minerals (CIPW) 90
 - Trace element 74
 - Petrography 37

- Hematite
 - Syenite dike 23
- Hornblende
 - Amphibolite 11
 - Garnetiferous gneiss 10
 - Hornblende gneiss 9
 - Monzonite to quartz monzonite pegmatite dikes 21,22
 - see also* Amphibole
- Hornfels
 - Amphibolite 11
 - Chemical analyses 13
- International Minerals and Chemical Corp. (Canada) Ltd. 31
- K-Ar (biotite) isotopic ages 26
 - Table 27
- Kennco Explorations (Canada) Ltd. 28
 - Figure
 - Magnetic data 29
 - Property description 31
- Lamprophyre dikes 23-24
 - Chemical analyses
 - Major element 72
 - Normative minerals (CIPW) 104
 - Trace element 88
- Lithologic units
 - Table 6
- Long Lake 14,19,20,21
- Magnetite
 - Amphibolite 8,11,28
 - Diorite porphyry 14
 - Gabbro 21
- Metamorphism 27
- Microcline
 - Monzonite to quartz monzonite 20
 - Pegmatite dikes 10
 - Quartz monzonite to granite 20
 - Syenite dike 22
- Monzonite
 - Chemical analyses
 - Major element 65,66,71,72
 - Normative minerals (CIPW) 90,91,92,101,103
 - Trace element 74,75,76,85,87
 - Fractures/breccia
 - Photo 15,16
 - Pegmatitic dike 24
 - AFM plots 25
 - Photo 22
 - Petrography 45,46,53,54,55,58,59-60,62
 - see also* Quartz monzonite
 - Monzonite to quartz monzonite 24
 - AFM plots 25
 - Chemical analyses
 - Average compositions 107
 - Major element 65-67
 - Normative minerals (CIPW) 90-94
 - Trace element 74-78
 - Pegmatite dikes
 - Petrography 21-22
 - Photo 22
 - Petrography 19-20
 - Monzonite, amphibole-biotite
 - Chemical analyses
 - Major element 66,69
 - Normative minerals (CIPW) 91,98
 - Trace element 75,82
 - Petrography 35,47
 - Monzonite, amphibole-pyroxene-biotite
 - Chemical analyses
 - Major element 70
 - Normative minerals (CIPW) 100
 - Trace element 84
 - Petrography 54
 - Monzonite, aplitite
 - Chemical analyses
 - Major element 65,66
 - Normative minerals (CIPW) 89,92
 - Trace element 73,76
 - Petrography 34,50
 - Monzonite aplitite, biotite-amphibole
 - Chemical analyses
 - Major element 66
 - Normative minerals (CIPW) 91
 - Trace element 75
 - Petrography 48-49
 - Monzonite aplitite, hornblende
 - Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 93
 - Trace element 77
 - Petrography 64
 - Monzonite, biotite-amphibole
 - Chemical analyses
 - Major element 67,68,69,70,71
 - Normative minerals (CIPW) 93,95,98,99,102
 - Trace element 77,79,82,83,86
 - Petrography 34,37,49,51-52,63-64
 - Monzonite, biotite-hornblende
 - Chemical analyses
 - Major element 71
 - Normative minerals (CIPW) 101
 - Trace element 85
 - Petrography 58
 - Monzonite, hornblende
 - Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 93
 - Trace element 77
 - Petrography 63
 - Monzonite, quartz-bearing
 - Chemical analyses
 - Major element 65,66
 - Normative minerals (CIPW) 90,92
 - Trace element 74,76
 - Petrography 53,58

- Monzonite, quartz-bearing, amphibole
 - Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 93
 - Trace element 77
 - Petrography 64
- Monzonite, quartz-bearing, amphibole-biotite
 - Chemical analyses
 - Major element 65, 66, 67, 71
 - Normative minerals (CIPW) 90, 92, 93, 101
 - Trace element 74, 76, 77, 85
 - Petrography 52, 55, 57
- Monzonite, quartz-bearing, amphibole-olivine
 - Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 94
 - Trace element 78
 - Petrography 38
- Monzonite, quartz-bearing, biotite
 - Chemical analyses
 - Major element 66, 67
 - Normative minerals (CIPW) 92, 93, 94
 - Trace element 76, 77, 78
 - Petrography 63, 64
- Monzonite, quartz-bearing, biotite-amphibole
 - Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 93
 - Trace element 77
 - Petrography 64
- Monzonite, porphyritic amphibole-biotite
 - Chemical analyses
 - Major element 72
 - Normative minerals (CIPW) 104
 - Trace element 88
 - Petrography 50
- Monzonite, pyroxene
 - Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 94
 - Trace element 78
 - Petrography 59
- Monzonite, pyroxene-amphibole
 - Chemical analyses
 - Major element 70
 - Normative minerals (CIPW) 99
 - Trace element 83
 - Petrography 52
- Monzonite, pyroxene-amphibole-biotite
 - Chemical analyses
 - Major element 68
 - Normative minerals (CIPW) 96
 - Trace element 80
 - Petrography 40
- Monzonite, pyroxene-biotite-amphibole
 - Chemical analyses
 - Major element 70, 71
- Normative minerals (CIPW) 100, 102
 - Trace element 84, 86
- Petrography 35, 56
- Monzonitic rocks 8
- Monzonitic to granitic rocks, pegmatitic 7
- Myrmekite 28
 - Diorite to monzonite, coarse-grained 17
 - Diorite to monzonite, fine-grained 17
 - Monzonite to quartz monzonite 20
- Orthogneiss
 - Chemical analyses 12-13
 - Petrography 8-11
- Orthopyroxene
 - Garnetiferous gneiss 10
- Paragneiss
 - Chemical analyses 12-13
 - Petrography 8-11
- Pegmatite dikes
 - Granitic
 - Petrography 10
 - Monzonite to quartz monzonite, hornblende
 - Petrography 21-22
 - Photo 22
- Pegmatite, quartz-hornblende monzonite
 - Chemical analyses
 - Average composition 110
 - Major element 72
 - Normative minerals (CIPW) 104
 - Trace element 88
- Perthite
 - Diorite to monzonite, coarse-grained 17, 18-19
 - Diorite to monzonite, fine-grained 15, 17
 - Metamorphism 27
 - Monzonite to quartz monzonite 19
 - Pegmatite dike 22
 - Porphyritic syenite dikes 23
 - Quartz monzonite to granite 20
- Plagioclase
 - Amphibolite 11
 - Basalt xenolith
 - Chemical analyses 13
 - Diorite
 - Chemical analyses 18
 - Diorite to monzonite, coarse-grained 17, 18
 - Diorite to monzonite, fine-grained 15, 16-17
 - Diorite porphyry 14
 - Gabbro 21
 - Garnetiferous gneiss 10
 - Hornblende gneiss 9
 - Metamorphism 27
 - Monzonite to quartz monzonite 19-20
 - Pegmatite dike 22
 - Porphyritic syenite dikes 23
 - Quartz monzonite to granite 20
 - Quartzitic gneiss 9

- Protoclastic texture 24
 Diorite to monzonite, coarse-grained 17, 18, 19
 Diorite to monzonite, fine-grained 17, 28
 Pyrite
 Syenite dike 23
 Pyroxene
 Basalt xenolith
 Chemical analyses 12
 Diorite
 Chemical analyses 18
 Metamorphism 27
 Pyroxene, augite
 Diorite to monzonite, coarse-grained 17
 Diorite to monzonite, fine-grained 15
 Diorite porphyry 14
 Gabbro 21
 Hornblende gneiss 9
 Quartz
 Amphibolite 8, 11
 Garnetiferous gneiss 10
 Monzonite to quartz monzonite 20
 Pegmatite dikes 10
 Quartz monzonite to granite 20
 Quartzitic gneiss 9
 Quartz monzonite
 Chemical analyses
 Major element 65, 68
 Normative minerals (CIPW) 89, 90, 95
 Trace element 73, 74, 79
 Dikes/Fractures
 Diorite to monzonite, fine-grained 14
 Photo 15, 16
 Petrography 35, 36-37, 48
 Quartz monzonite to granite 24
 AFM plots 25
 Chemical analyses
 Average compositions 106
 Major element 65
 Normative minerals (CIPW) 89-90
 Trace element 73-74
 Petrography 20
 Photo 21
 Quartz monzonite, biotite
 Petrography 38-39
 Recommendations
 Future study 29-30
 Prospecting 31-32
 Rb-Sr isochron ages 26
 Figure 26
 Saussuritization
 Plagioclase 17, 18, 19
 Shawmire Anorthosite Complex 9, 10, 27, 28
 Shiners Lake 6, 8, 9, 10, 14, 17, 28, 29
 Strontium 6
 Structural geology
 Regional 27
 Internal 27-28
 Sulphide
 Amphibolite 11, 31
 Syenite, amphibole-pyroxene
 Chemical analyses
 Major element 71
 Normative minerals (CIPW) 101
 Trace element 85
 Petrography 61
 Syenite aplite
 Chemical analyses
 Major element 66
 Normative minerals (CIPW) 91
 Trace element 75
 Petrography 42, 46-47
 Syenite aplite, quartz-bearing
 Chemical analyses
 Major element 67
 Normative minerals (CIPW) 94
 Trace element 78
 Petrography 42
 Syenite, biotite-amphibole
 Chemical analyses
 Major element 72
 Normative minerals (CIPW) 104
 Trace element 88
 Petrography 40
 Syenite dikes
 Petrography 22-23
 Syenite pegmatite
 Chemical analyses
 Major element 72
 Normative minerals (CIPW) 104
 Trace element 88
 Petrography 33-34
 Syenite pegmatite, amphibole
 Chemical analyses
 Major element 72
 Normative minerals (CIPW) 104
 Trace element 88
 Petrography 50-51
 Syenite, plagioclase, biotite, porphyritic dike
 Chemical analyses
 Major element 72
 Normative minerals (CIPW) 104
 Trace element 88
 Petrography 23
 Syenodiorite 14
 Chemical analyses
 Major element 68, 69, 70, 71, 72
 Normative minerals (CIPW) 96, 98, 100, 101, 103
 Trace element 80, 82, 84, 85, 87
 Petrography 42-43, 47, 55, 57-58, 59, 61-63
 Photo 15, 16

- Syenodiorite, amphibole-biotite
 - Chemical analyses
 - Major element 69,71
 - Normative minerals (CIPW) 97,101
 - Trace element 81,85
 - Petrography 46,57
- Syenodiorite, amphibole-pyroxene-biotite
 - Chemical analyses
 - Major element 67
 - Normative minerals (CIPW) 94
 - Trace element 78
 - Petrography 57
- Syenodiorite, biotite-amphibole
 - Chemical analyses
 - Major element 68,71
 - Normative minerals (CIPW) 95,102
 - Trace element 79,86
 - Petrography 34,36,38
- Syenodiorite, biotite-pyroxene
 - Chemical analyses
 - Major element 69
 - Normative minerals (CIPW) 97
 - Trace element 81
 - Petrography 44
- Syenodiorite, perthite-bearing, biotite-amphibole
 - Chemical analyses
 - Major element 70
 - Normative minerals (CIPW) 100
 - Trace element 84
 - Petrography 55-56
- Syenodiorite, pyroxene-amphibole-biotite
 - Chemical analyses
 - Major element 68
 - Normative minerals (CIPW) 95
- Trace element 79
 - Petrography 37
- Syenodiorite, pyroxene-biotite
 - Chemical analyses
 - Major element 68,69
 - Normative minerals (CIPW) 95,97
 - Trace element 79,81
 - Petrography 40,44
- Trachytoidal texture
 - Diorite to monzonite, coarse-grained 28
- Trondhjemite
 - Photo 8
- Twinning
 - Microcline 20
 - Perthite 17,18,19
 - Plagioclase 17,18
- Xenoliths
 - Amphibolite 11,28
 - Chemical analyses 12-13
 - Metamorphism 27
- Zircon
 - Biotite
 - Quartz monzonite to granite 20
- Zoning
 - Plagioclase
 - Diorite to monzonite, coarse-grained 18
 - Diorite to monzonite, fine-grained 17
 - Monzonite to quartz monzonite 20
 - Pyroxene
 - Diorite to monzonite, fine-grained 15

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